SERVICE INFORMATION
PHYACTION SUPPORTA

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Phyaction is manufactured in The Netherlands by Uniphy BV
P.O.Box 558 , NL-5600 AN Eindhoven, the Netherlands
Tel. +31 499 491802 Fax. +31 499 474734

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CHAPTER 1 GENERAL INFORMATION

1.1 introduction

The Phyaction Supporta is suitable for administering electrotherapy and ultrasound therapy, as well as for a combination of both types of therapy. There is one 2-pole medium frequency interferential current that can be applied. There are also two TENS currents, TENS continuous and TENS burst. The ultrasound therapy can be applied with a 4 cm^2 or 1 cm^2 (optional) ultrasound head. It is possible to use ultrasound therapy in combination with the interferential current or TENS continuous.

For detailed information about the features and operation of the device we suggest that you should read the user manual.

1.2 Safety test

To ensure the patient's safety a safety test has to take place every time after the equipment has been serviced. The Phyaction Supporta is a class II BF appliance. Carry out the safety test with a safety tester that complies with the IEC 601-1 demands. See section 3.2 for further details.

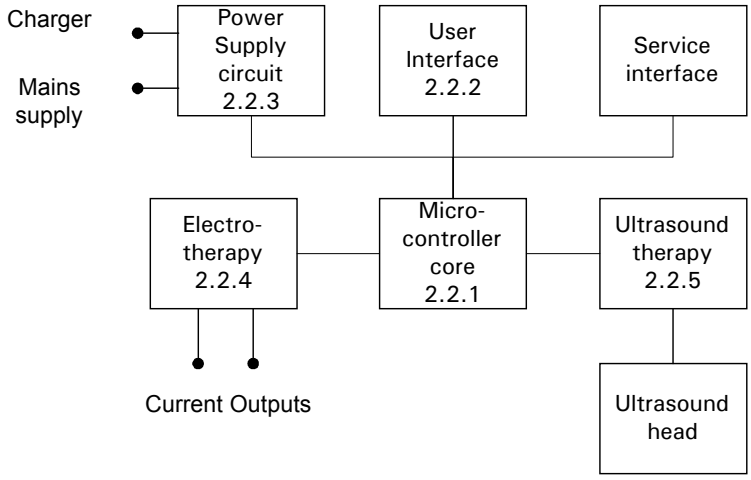
CHAPTER 2 THEORY OF OPERATION

2.1 Introduction

In this chapter the electronics of the Phyaction Supporta will be explained. A description on the level of functional block diagrams will be used. The electronics will be described in more depth when safety aspects are concerned.
The Phyaction Supporta is a device for ultrasound-, electro- and combinationtherapy. The user -the physical therapist- can set a number of parameters. The parameters are converted in electric signals for the ultrasound and electrotherapy circuits by a microcontroller.
The microcontroller continuously checks whether the ultrasound circuit produces the proper amount of ultrasound power.
The microcontroller also checks the safety circuit each time the Supporta is switched on. Further it checks the patient resistance during treatment to verify the patient current.

2.2 General block diagram

The block diagram of the Phyaction Supporta is shown in the figure below.



The microcontroller core (μC) controls the complete device.

All interactions between the device and the user are executed via the user interface. The user interface contains the switch panel, the ultrasound intensity knob, the LCD and the LEDs.

The power supply circuit selects the power source (a battery or a mains supply) and also converts this voltage to 5 Volts. The device can be switched on with a switch at the back.

The electrotherapy circuit consists of a switch-mode power supply, a generator, the intensity knob and the safety circuit.

The ultrasound circuit consists of a switch-mode power supply, a generator and a head identification circuit.

The serial service interface is used for extended service features.

2.2.1 The microcontroller core

The microcontroller used in the Phyaction Supporta is an 80C166. The 80C166 is a 16-bit RISC controller with the following features on the chip:

- 1k byte RAM memory
- 5 timer / counters
- 10 channel 10-bit AD converter
- 76 general I/O lines
- 2 UART for serial data transfer (e.g. RS232)
- watchdog timer
- capture / compare system

Besides the microcontroller the following parts are present in the core:

- (32 kByte) RAM data memory
- 1 Mbit EPROM program and constant data memory
- 512 byte I^2C E^2PROM non-volatile data memory
- HCMOS IC's for decoding and buffering purposes
- a power-on reset circuit

2.2.2 The User Interface

2.2.2.1 The switch panel and LEDs

The switch panel is a matrix of 14 metal dome membrane keys, a matrix of 20 LEDs and two single LEDs. The matrices of the keys and the LEDs are connected to the μC via a tail. The user can use the keys to set and change a number of parameters such as pulse width, duty-cycle and treatment time.

The top layer of the switch panel is made of polyester.

2.2.2.2 The ultrasound intensity control

See section 2.2.5.1,

2.2.2.3 LCD

An alpha numerical LCD with LED backlight is used for the display. During battery operation the backlight will be switched off by the μC for power saving when no keys are pressed.
The LCD displays the treatment time and some parameter settings of the electrotherapy.
The contrast is controlled by the μC through a switched-capacitor voltage inverter.

2.2.3 The power supply circuit

2.2.3.1 The supply selector

If present the device is powered by the battery unless an active mains supply is connected. The supply selector determines whether the battery or the mains supply is to be used.

2.2.3.2 The Battery

The battery consists of ten rechargeable NiCd cells with a capacity of 1.7Ah. The battery voltage is typical 12 V with a maximum of 15 V. The battery voltage is monitored by the μC and it switches the device off if the voltage drops to 10 V.

2.2.3.3 The charger

The battery can be charged with an external charger which fully charges the battery in 14 hours. The charger is a transformer and rectifier (without smoothing capacitor), generating a DC current of 200 mA average. The open circuit voltage is approximately 24 Vdc.
The charger comes in 3 different models:
model 401 100 ...120 V with an American style mains plug
model 403 220 .. 240 V with an European style mains plug
model 404 220 .. 240 V with a British style mains plug

The charge current can only reach the pcb if a battery is connected, because this current is routed through the battery connector which contains a shorting link.

2.2.3.4 The mains supply

The mains supply is a switch-mode power supply with a voltage of 18 V typical and a maximum average DC current of 1.8 A.
The voltage supplied to the pcb must never exceed 20 V due to limited component voltages. The voltage should be 16 V minimum, because at lower voltages the internal power source selector will not operate properly.

2.2.3.5 Internal battery charger

When the mains supply is connected and a battery is present, a current source serves as internal battery charger, charging the battery with approximately 170 mA.

2.2.3.6 The +5 V power supply

The voltage from the supply selector is converted to +5 V by a switch-mode power supply (SMPS). This SMPS can be switched off by the controller, in case of a low battery voltage, with the signal '5V-SD\' (active low). After power-up there is a limited time in which the μC should take over the SMPS enable signal from the bootstrap circuit. For fault finding purposes jumper J101 'force 5V' is provided. Shorting this jumper will keep the +5V up even if the μC fails to assert the '5V-SD/' signal.

2.2.3.7 The charge indicator

When the battery is charged the charge indication LED, on the console, is activated.
The circuit driving the LED is independent of the 5 V SMPS (see paragraph 2.2.3.6), because the circuit (and the LED) should also work when the device is switched off.

2.2.4 Electrotherapy circuits

2.2.4.1 General

To ensure the safety of the patient both the μC and the safety circuit monitor the generated current against the set value and limit value allowed by the IEC-standard.

2.2.4.2 Signal generator

The 4 kHz carrier wave of the MF signal is a square wave (not a sine wave) generated directly by the μC. The amplitude modulation is done by an 8-bit multiplying DAC. This DAC is controlled by

the μC with DMA-control. The reference voltage for the DAC is directly derived from the wiper voltage of the current control potentiometer.

The TENS pulses are also generated by the μC. There is an additional hardware TENS pulse limiter ensuring the pulse width not to exceed 200 μs and that the pulse frequency not to exceed 400 Hz.

2.2.4.3 Output stage

The signal from the signal generator drives the output stage. This circuit has two adjustments, one for the maximum current of 100 mA peak and one for the minimum current of less than 300μA. The output stage consists of a transformer driven by 2 FETs with a very low on-resistance, to limit the power loss. Because the losses in the FETs are very low no heat sink is needed. A third FET is used exclusively for TENS generation operating as a gated current source.

2.2.4.4 Switch-mode power supply

The SMPS supplies the output stage with a voltage between 0 V and 5 V. In case of MF current, the control circuit regulates the voltage of the SMPS in such a way that the set current (ETset) flows, independent of the patient resistance. If the patient resistance is too high the voltage will clip at 5V.
In case of TENS current the SMPS is set to maximum, because the control circuit is too slow to follow the TENS pulses.

2.2.4.5 Intensity control

The electrotherapy intensity is set by a potentiometer with a switch. The switch signals to the μC that the operator has put the control into operation. The position of the sweeper of the potentiometer is a direct measure for the set value of the current. The sweeper is the reference voltage (ETref) for the signal DAC. Also it is used for comparison with the read value of the current by the safety circuit.

2.2.4.6 Safety circuit

In this circuit the primary output current is used to monitor whether the output exceeds the limit of 100 mA_{peak} or 150% of the set value by the intensity control. Also the intensity control is monitored for interruptions of the ground and guard terminal. All the safety functions are achieved by comparators, fully independent of the μC. In case of a fault the comparators switch the safety relay off, which interrupts the patient current. Even in case of maximum intensity, this will happen so fast that the energy contents of the resulting pulse will be below the allowed limit. Once the safety relay has been switched off, it remains in this state and the device must be switched off.

2.2.4.7 Reference voltages

There are two reference voltages in the safety circuit: 4.096 V, used for the safety comparators and 2.50 V, used for the ET potentiometer and ET and US signal generation.
The reference voltage (ETref) for the DAC is derived from the 2.50 V via the electrotherapy potentiometer.

2.2.4.8 Test control circuit

During the selftest of the device the safety circuit is tested: guard and ground connection of the potentiometer, 150% and the limit, to ensure that the safety circuit works.

During a fixed time the μC can activate the safety relay. After this time has expired, the μC can only switch off the safety relay, e.g. when an error has been detected. The relay 'De-energize' ensures that no current can flow through the patient during the selftest.

2.2.5 Ultrasound circuits

2.2.5.1 The ultrasound intensity control

The ultrasound intensity is set by a potentiometer with a switch. Both the potentiometer and switch are directly connected to the μC. From the position of the potentiometer the μC calculates the amount of power that is to be supplied to the output stage. The switch signals to the μC that the operator has put the control into operation.

2.2.5.2 PLL

The required ultrasound frequency of 0.7 MHz to 1.0 MHz is generated by a phase locked loop (PLL). The PLL transforms the low-frequent signal (Refclk), generated by the μC, up to the required drive frequency which is twice the ultrasound frequency. The modulator divides this frequency by two and mixes it with the desired duty-cycle.
If the PLL is out of lock, the Lock-error signal (USerror\) is used to stop the modulator in order to prevent erroneous frequencies produced by the treatment head.

2.2.5.3 The modulator

To obtain a symmetrical drive signal for the power stage, the modulator switches its outputs with half the input frequency. Synchronously the modulator mixes the duty-cycle signal with the ultrasound frequency.
With the Lock-error signal the modulator can be forced to shutdown if the PLL is out of lock.

2.2.5.4 The switch-mode power supply (SMPS)

The SMPS supplies the output stage with a voltage between 0 V and 5 V.
The SMPS for the ultrasound circuit is only active if the ultrasound therapy is chosen. The μC de-activates the SMPS via a shut-down (US-SD\).
The SMPS output voltage is linear proportional to its input voltage (Usset). Thus the μC can change the ultrasonic power by setting Usset proportional to the square root of the desired output power.
The μC continuously monitors the output voltage (USV) of the SMPS. If the output voltage is too high e.g. due to a hardware failure, the μC will shut down the ultrasound circuit and give an error message.

2.2.5.5 The power stage

The power stage is a switched half bridge. The generated output is controlled by USV, generated by the SMPS. The above mentioned modulator controls whether the power stage is active. Power MOSFETs are used as switching elements. The MOSFETs are driven by with a small delay in the on-ramp, to prevent them of being active simultaneously.

2.2.5.6 Impedance matching

The ultrasound transducer shows mainly a capacitive load. Its impedance differs, among other things, with the size of the transducer and its operating frequency. For this reason the μC can match the impedance by switching one or two inductors in series depending on the head being

used. To ensure that all devices give the same output, the coils, for both the large head and the small head, are each adjusted to a specific inductance. **Do not change this adjustment.**

The μC monitors the match of inductor(s) and head by checking the current (USI) through the MOSFETs. This current is proportionally to the current through the head. If there is a mismatch, due to bad acoustic coupling, USI will increase and signal the μC to decrease the ultrasonic power. The duty-cycle is set for the ultrasonic output power not to exceed 0.2 W/cm². When the match is established ultrasonic output power is restored to the set ultrasonic power.

2.2.5.7 Ultrasound head

The ultrasound head converts the electric signal into ultrasonic vibrations. The transducer, with a diameter depending on the head size, is glued in an aluminium cup that minimises electromagnetic radiation and enables the transducer to be used on the operating frequencies.
The aluminium cup can also be used as a second electrode for combination therapy. A separate electrode needs to be connected to the safety socket for combination therapy.

An OTP in the connector of the head enables the μC to detect whether a head is connected and to recognise the type of head that is connected. This OTP also contains specific head related information. Thus enabling the μC to set the head specific frequencies and ultrasonic power.

2.2.5.8 Head Identification Circuit

The head identification circuit enables the μC to read the contents of the OTP in the connector of the ultrasound head. If the checksum calculated by the μC differs from the checksum in the OTP, the head will not be recognised.
If a head parameter, necessary for the ultrasound circuit to generate the ultrasound power, exceeds its limits, the μC will produce an error message.

CHAPTER 3 PERFORMANCE CHECK

3.1 Safety inspection

This inspection is for technical maintenance purposes only. It is recommended that this test is carried out once a year. If the appliance is serviced, the full IEC 601-1 tests have to be carried out. A short description of these tests is given in section 3.2.

3.1.1 Visual inspection

Passed, when all applicable items are answered with YES.

	yes	no
Is the user manual there?		
Is the casing of the appliance undamaged?		
Is the label well readable?		
Are the controls, display, lights and connectors all right?		
Are the power input and the equipotentiality busbar all right?		
Are ultrasound treatment heads, cables and connectors undamaged? (Pay special attention to possible leaks in the treatment heads, such as cracks or loosened seems.)		
Are the labels on the ultrasound treatment heads readable?		

3.1.2 Functional test

Passed, when all applicable items are answered with YES (or not applicable).

		yes	no
Is the automatic selftest executed successfully at power on?			
Is the appliance able to detect both treatment heads?	1 cm²		
	4 cm²		
Is the ultrasound output correct for both treatment heads	1 cm²		
at maximum intensity?	4 cm²		

3.1.3 Test of the electrical safety according to VDE 0751

Parameter	Measured value	Limit	Remarks
Enclosure leakage current	μA	< 1000 μA	
Patient leakage current	μA	< 5000 μA	

Also register the measured values in the device records and compare them with the values measured in the past to alert for a possible potentially dangerous tendency.

3.2 IEC 601-1 safety tests

For the full description of these tests we refer to the IEC 601-1 (1988) for Class II, Type BF equipment. Here is just a short reminder list of the tests and the test limits.

Measurements	limits
Insulation resistance applied part	> 2.0 MΩ
Enclosure leakage current normal	< 100 μA
Enclosure leakage current open lead	< 500 μA
Enclosure leakage current reverse	< 100 μA
Enclosure leakage current open lead	< 500 μA
Patient leakage current normal	< 100 μA
Patient leakage current open lead	< 500 μA
Patient leakage current reverse	< 100 μA
Patient leakage current open lead	< 500 μA
Mains on applied part normal	< 5000 μA
Mains on applied part reverse	< 5000 μA
Dielectric strength A.P. + CASE to MAINS *	> 1500 V_{rms}
Dielectric strength MAINS + CASE to A.P. *	> 1500 V_{rms}

* These tests need only be executed if repairs have been made in the mains part or in the output circuits.

CHAPTER 4 TROUBLE SHOOTING

4.1 Introduction

If a Phyaction Supporta is defective, in most cases the unit will detect an error in the automatic self test. A full description of this test will therefore help the service technician in finding the fault. In the next section you will find this description. In section 4.3 you will find a list of all possible error messages and possible causes.

4.2 Description of the automatic selftest.

4.2.1 General

The selftest checks proper functioning of the safety relay and circuits and is activated every time the unit is switched on. The tests are performed by the microprocessor and last for approximately 3 seconds. Both intensity regulators should be in the zero position i.e. maximum counter clock wise. This is checked at the start of the selftest. If an intensity regulator is not at zero an error will be reported by graphic symbols prompting to turn ET intensity to 0 and/or turn US intensity to 0) and an error shutdown procedure will be initiated as described below.

The safety relay driver circuitry is accessible to the microprocessor for 3 seconds after power up of the unit. After this period the microprocessor will not be able to switch the safety relay on any more. The control lines used for test purpose are only accessible by the microprocessor if the ET intensity regulator is in the zero position as an extra precaution against hard- or software errors.

4.2.2 ERROR shutdown procedure

The safety circuit will switch off the safety relay immediately in the event of an error, thus disconnecting the drive signals from terminals to avoid hazards to the patient.
In addition to this the μC will, if it detects an error either from the safety circuit or otherwise, call an error function ("Error") which will perform the following actions:

- All interrupts are disabled.
- ET Dac to zero: no signal to the ET SMPS
- US Dac to zero: no signal to the US SMPS
- ET SMPS is switched off
- ET testlines are switched to inactive state
- ET output drive signals are switched off ET-PHA, ET-PHB
- ET Safety relay is switched off: the patient circuit disconnected. This is a latched state that can only be exited by switching off the unit.
- Dummy relay is switched on: The output is short circuited.
- De-energize relay is switched on.
- The US testline will be switched to inactive
- The US SMPS is switched off
- The US dutycycle is switched off
- An error message ("Err", an error number and a value) is displayed on the LCD display.
- Wait in an endless loop.

In the endless loop the state of the power supply is observed. If only a battery is connected and the power supply voltage drops to the "deep discharge" voltage (10 V) the microprocessor will also shut down the +5V SMPS.
For processor kernel errors (processor, RAM or EPROM) the processor will display the error message for 5 seconds and then shut down the +5V SMPS.

4.2.3 General test description

The microprocessor circuits are tested first, followed by the ET and finally the US circuits.

In case the unit does not complete this selftest and no error message is displayed and the internal wiring is connected properly the following items are suspect:

- Supplies (mains and other)
- Microprocessor
- Program EPROM
- Address, data or control lines

4.2.4 Microprocessor test

Any fault found will stop the selftest and an error message will be displayed

The following tests are performed:

1. Microprocessor internal check. Some ALU instructions are executed and verified against the known results. Also verified is whether, the contents of some special function registers which should be 0 after a RESET, are indeed 0. In case of a failure: 100-xx (errCPU).
2. Internal RAM. The internal RAM will be tested with a write/read test. In case of a failure: 100-00 (errCPU), 100-10 (enrCPU_IRAM).
3. External data storage. The external 32K RAM will be tested with a write/read test. This also checks most address, data and read/write control lines. In case of a failure: 110-xx (errXMEM).

4. External program storage. By means of a checksum test on the accessible part of the 128K EPROM the data integrity of the program stored is tested. In case of a failure: 110-20 (enrXMEM_ROM0). A small part of the EPROM memory space is overlapped by processor internal addresses. These are not checked.

After these tests it can be assumed that the processor kernel operates correctly.

4.2.5 ET Initial Test

The following power up conditions are checked:

1. ET-ERROR line should be active. If not: 420-40 (enrETERROR).
2. Intensity regulator should be at zero, checked by means of the potentiometer switch and analog input. If switch not at zero: 400-10 (enrSWNOT0). If analog input larger than 0.16V (10%): 400-20 (enrTOHIGH).
3. As there should not be any ET output generated the ETV signal should be very low. If it is higher than 0.1V: 410-10 (enrETV).
4. As there is no ET output the ETI signal also should be very low. If it is higher than 0.1V: 410-20 (enrETI).

4.2.6 ET Relay test

In the following test sequence the safety, standby and dummy relays are tested for proper functioning. All tests are executed with the de-energize relay active: the output circuit is disconnected from a possibly connected patient. If the de-energize relay is not open and a patient is connected an error will be given during this part of the selftest. It is not tested any further, if it remains open no current will reach the patient.

The DAC is programmed in such a way that with a test reference voltage applied via the TEST Y3 line approximately 4 mA DC will flow through the output circuit, if connected either through an external connection or the dummy relay. The voltage level of the ET power supply is proportional to the resistance in the output (patient) circuit with a given current. This level is used to test the output circuit resistance. When checking for an open circuit a voltage on this point below 0.5V is recognised as an error. Conversely a voltage above 0.1 V while testing for a closed circuit is recognised as error.

When the safety relay is energised the contacts in both channels are closed. The dummy relay will short circuit the output channels if energised. The initial condition of these relays prior to test is safety relay off and dummy relay on.

1. Test if the safety relay is off.
   A low current (approximately. 4 mA) is applied to the output circuit. If a closed circuit is detected 420-10 (enrRELSAFETY) will occur.
2. Test if the ET errorline becomes activated if the safety relay is switched on.
   The output is set to 0 (testline TEST Y3 is disabled). The ET safety relay is switched on. If the errorline is activated it means that the safety circuit has activated it and 420-11 (enrRELSAFETY1) will occur.
3. Test if the safety relay makes contact.
   The testline TESTY3 is enabled: a low current (4 mA) is applied to the output circuit). The ET errorline should still be inactive, otherwise 420-40 (enrETERROR) will occur. With the safety relay on and the dummy relay on a closed circuit should exist, an open circuit will result in 420-12 (enrRELSAFETY2).

4. Test for external (patient) connections.
   The dummy relay is switched off.
   The ET errorline should still be inactive, otherwise 420-40 (enrETERROR) will occur.
   The output circuit should be open again. A closed circuit suggests an external load and will result in 420-20 (enrRELDUMMY).
5. Test if the dummy relay makes contact.
   The dummy relay is energized.
   The ET errorline should still be inactive, otherwise 420-40 (enrETERROR) will occur.
   The outputs should be shorted, else 420-22 (enrRELDUMMY2) will be given.
6. Check the ET errorline.
   The safety relay is switched off.
   An open circuit should exist, else 420-30 (enrETSAFETY3). The ET errorline should have become active. If it hasn't 420-31 (enrSAFETY4) will be given.

If these tests have passed the safety and dummy relay are functioning and the de-energize relay has disconnected the sockets.

In the next test the safety relay is tested under full load conditions.

1. Check the ET errorline
   The output is set to 0 mA. The safety relay is set to 'on'.
   The ET errorline should remain inactive, else 420-32 (enrRELSAFETY5) is given.
2. Test if the safety relay switches under full load.
   The DAC's are programmed for an output current of 125% maximum operating current.
   The safety limit check circuits should activate the ET error line causing the safety relay to open.
   If the ET errorline is not activated 420-33 (enrSAFETY6) is generated.
3. Test if the safety relay contacts open.
   If the above test passes but a closed circuit is detected (ET power supply voltage below 2.5 V) 420-34 (enrRELSAFETY7) is generated.

This test completes the verification of the safety relay.

4.2.7 safety limit check

In this test sequence the 150% comparator circuits are tested. The safety relay is energised and a closed output circuit is created by switching on the dummy relay.

1. ET testline TESTY2 is activated, this changes the reference voltage of the 150% comparator. If the ET error line is not activated 430-12 (enrET150REF) is given.
2. With the ET testline TESTY4 an output of 8 mA is simulated. As this is above the 3.3 mA the ET errorline should become active. If it doesn't 430-11 (enrET150OFF) is given.

This completes the 150% comparator check.

4.2.8 Maximum current safety limit check

This comparator checks for currents above the maximum allowable output current and should report an error if the output current rises above 110% of the maximum allowable. The maximum current is simulated by a testline connected to the comparator network.

1. Test the maximum current safety limit.
   Activate testline TESTY1, this changes the voltage of the limit comparator. If the ET errorline does not become active 440-10 (enrETLIMIT) is given.

This completes the maximum current safety limit check

4.2.9 ET Intensity regulator guard test

1. Test the ET intensity regulator ground guard.
   The testline TESTY6 is activated, this changes the regulator guard voltage. If the ET errorline does not become active 450-20 (enrETPOT) is given.
2. Test the ET intensity regulator reference guard.
   The testline TESTY5 is activated, this changes the reference voltage of the guard circuit. If the ET errorline does not become active 450-10 (enrETREF) is given.

This completes the check of the ET intensity regulator guard.
All testlines are deactivated and the output is set to 0 mA.

4.2.10 Ultrasound generator test

After the device is switched on the ultrasound generator is initialized to generate no output. The dutycycle is set off and the US head frequency is set at 700 kHz.

1. Intensity regulator should be at zero
   This is checked by means of the potentiometer switch, if it is not at zero: errUSPOT, 0.
2. US errorline should be inactive.
   The US errorline is read, if it is active an 320-10 (enrLINE1) is given.
3. Check output 0
   As the intensity is set a 0 no output should be given. Therefore the voltage on the USI line should be smaller than 0.2V. If not 310-10 (enrVUSI0) is given. Also the voltage on the USV line should be smaller than 0.2V, else 310-11 (enrVUS2) is given.
4. Check the PLL guard.
   The US head frequency is set at 0 kHz.
   The PLL should now detect an 'out of lock' condition and the US errorline should become active. If it does not become active: 320-10 (enrLINE1).
5. The US head frequency is set at 700 kHz. If the US errorline remains active: 320-30 (enrLINE3).

4.3 ERROR code summary

With all error messages an error value is displayed as well. In most cases this may give extra information about the cause of the error. This list is an short overview of the error messages.

message	value	description
100	00	Internal processor
110	10	External RAM
	20	External ROM
	30	External EEPROM
200	10	ET hardware error line active
	20	US hardware error line active
300	00	Potmeter not at 0 at start of test
310	10	US supply
420	40	ET relay
430	12	ET 150% comparator
440	10	ET limit comparator
450	20	ET Dose regulator
620	10	Ultrasound frequency
	20	Tens frequency
	30	MF base frequency
	40	Spectrum frequency
	111	ET waveform
630	00	Potmeter
640	20	Display timeout
	30	Eeprom timeout
800	20	System temperature to low
	30	System temperature to high
820	10	Battery deep discharge
B10	50	US head record incorrect

4.4 Adjustment procedures

There are no adjustments that can be carried out in the field. All adjustments should be carried out by Uniphy, because of the need for special test and measurement equipment.

4.5 Jumper Settings Supporta

jumper	default setting	function
J101	not placed	to force the 5V power supply on (normally activated by the microcontroller)
J401	not placed	to verify the level of the 150% safety circuit (electrotherapy)
J403	p2-3 / p4-5	to connect the safety circuits to the safety relay driver and the microcontroller. In alternate position (p1-2 / p3-4) the safety circuit is disabled
TP408-TP409	not connected	if connected the timer that disables the safety relay on control line is stopped, so the microcontroller will be able to set the relay on as long as the test points are connected. Note: The shunt should be applied before power-on.

CHAPTER 5 EXCHANGING BOARDS AND MODULES

5.1 Introduction

The most frequent service operations will be the exchanging of boards or modules, because it would be too time consuming and costly to do component level service in the field. When exchanging boards or modules there are a few things that should be noticed. These attention points will be described in this chapter.

If you want to exchange a module or a board you will have to open the appliance. It is probably most convenient to place the appliance on its front side, with the bottom side up. Open the battery compartiment by removing the two Allen screws. Disconnect and remove the battery. Inside the battery compartment are three Phillips screws. Unscrew the three screws and lift the bottom part off by tilting it slightly using the side of the handle as a pivot.

If you have exchanged a board or module, always test all the functions of the appliance. This functional test starts with switching the device on, checking all the LED's and the LCD. If no error messages appear, check the output currents and the ultra sound heads. After this you should run a safety test. A short description is given in section 3.1 and 3.2.

In general it is stressed that you should take the necessary precautions to prevent electrostatic discharges to the delicate electronic circuits of the unit. These precautions implicate that you should ground the unit, use a grounded desk overlay, ground the tools such as solder irons and you should be connected to ground by the usual wrist or ankle strap. You should also take precautions when you store or sent circuit boards, by using special ESD-protective packaging materials.

5.2 Replacing the battery

To exchange the battery you first remove the two Allen screws on the bottom side. Remove the battery lid. Disconnect the battery connector and replace the battery. Connect the battery connector and close the battery compartment with the two screws. For the life of the battery it is best if you charge the battery completely every time you charge it (i.e. connecting it to the charger for 14 hours). It is not allowed to dispose of the battery with domestic refuse. Instead, it must be discarded as small chemical waste for recycling.

5.3 Exchanging the software or the main board (PCB 492)

If you want to exchange the software or the main board of the appliance, you first open the appliance as described in section 5.1 and take the necessary precautions to prevent electrostatic discharges.

The software eprom is mounted on an IC-socket and can be replaced without soldering. The software version is printed on the label of the Eprom (i.e. V1.02). After replacing the Eprom, close the appliance. Carry out the functional and safety test as described in section 5.1.

5.4 Exchanging the software or the main board (PCB 492)

To exchange the main board, you first open the appliance as described in section 5.1. Remove the two intensity knobs. Remove the power cable and the output cables from the main board. Before removing the membrane panel flatcable first unlock the connector and carefully pull the flatcable out of the socket.

Unscrew the 5 Philips screws that tighten the main board to the front panel. These screws are located one in each corner of the main board and one in the middle. Now you can lift the main board from the front panel.
After replacing the main board, place the 5 screws back and connect the output and power cables. Carefully place the membrane flatcable in the connector and tighten the cable by locking the connector. After closing the unit mount the two intensity knobs. Perform a functional and safety test as described in section 5.1.

5.5 Exchanging the membrane panel or connector block

To exchange the membrane panel first open the appliance as described in section 5.1. and take the necessary precautions to prevent electrostatic discharges. Remove the main board as described in section 5.3. Take out the four plastic rings before removing the membrane panel from the plastic front part. Now you can pull the connector block from the carrier plate of the membrane panel.

To assemble the front slide the connector block firmly on the membrane panel. Place the membrane panel on the plastic front part followed by the four plastic rings. Replace the main board as described in section 5.4 and close the appliance as described in section 5.1.

CHAPTER 6 CIRCUIT DIAGRAMS

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Sheet 17 Components reflow side PCB 4922
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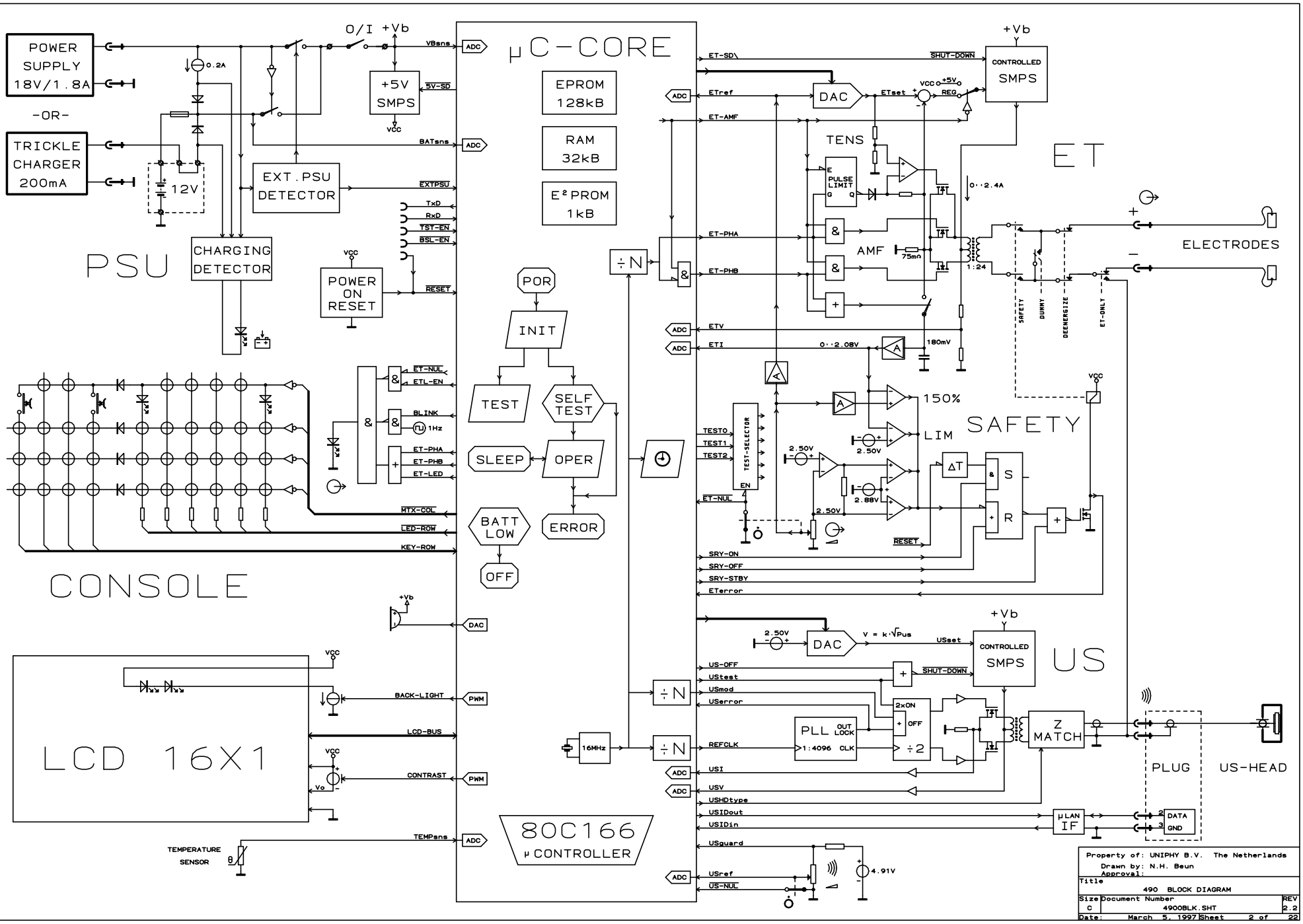
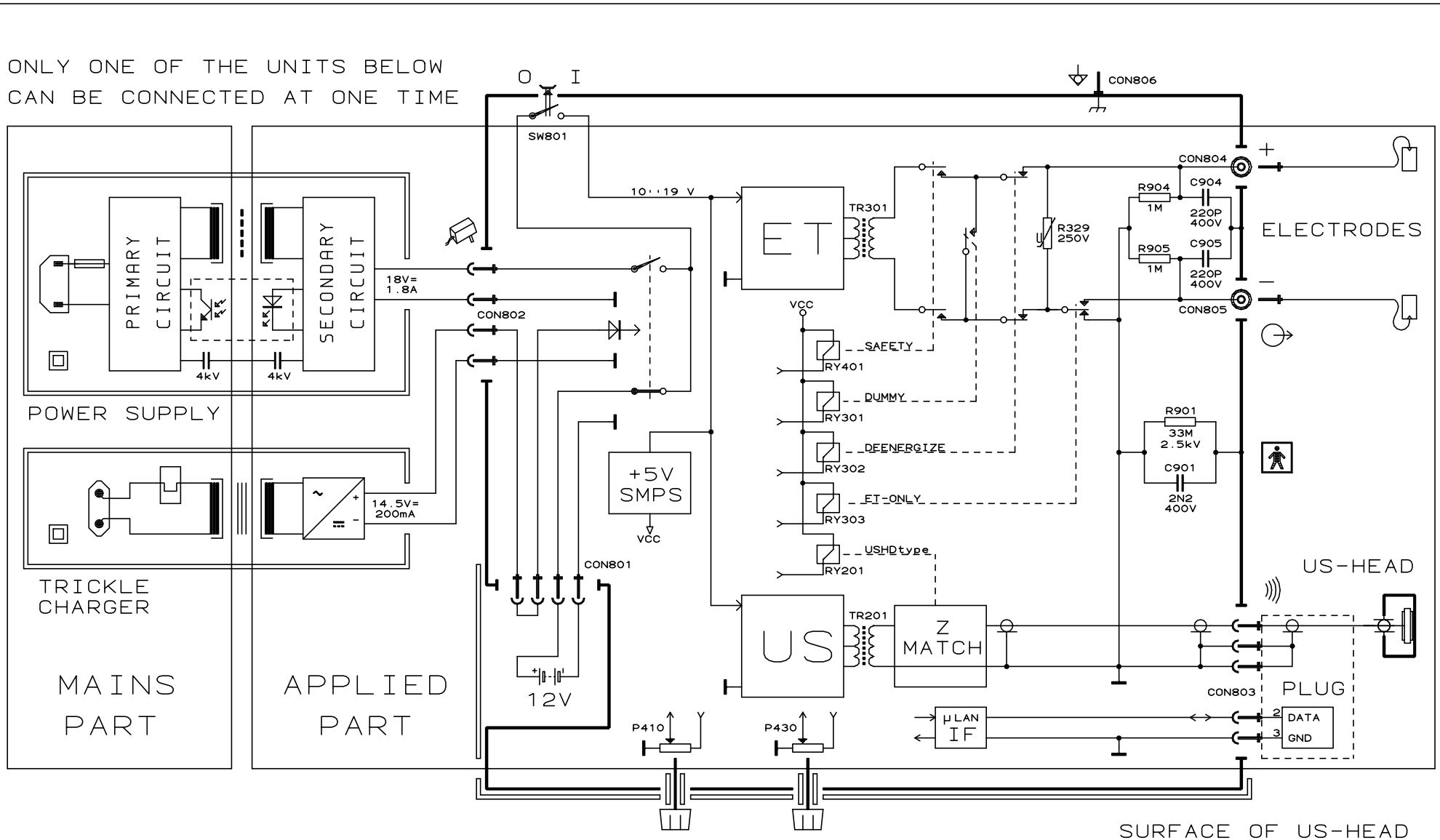
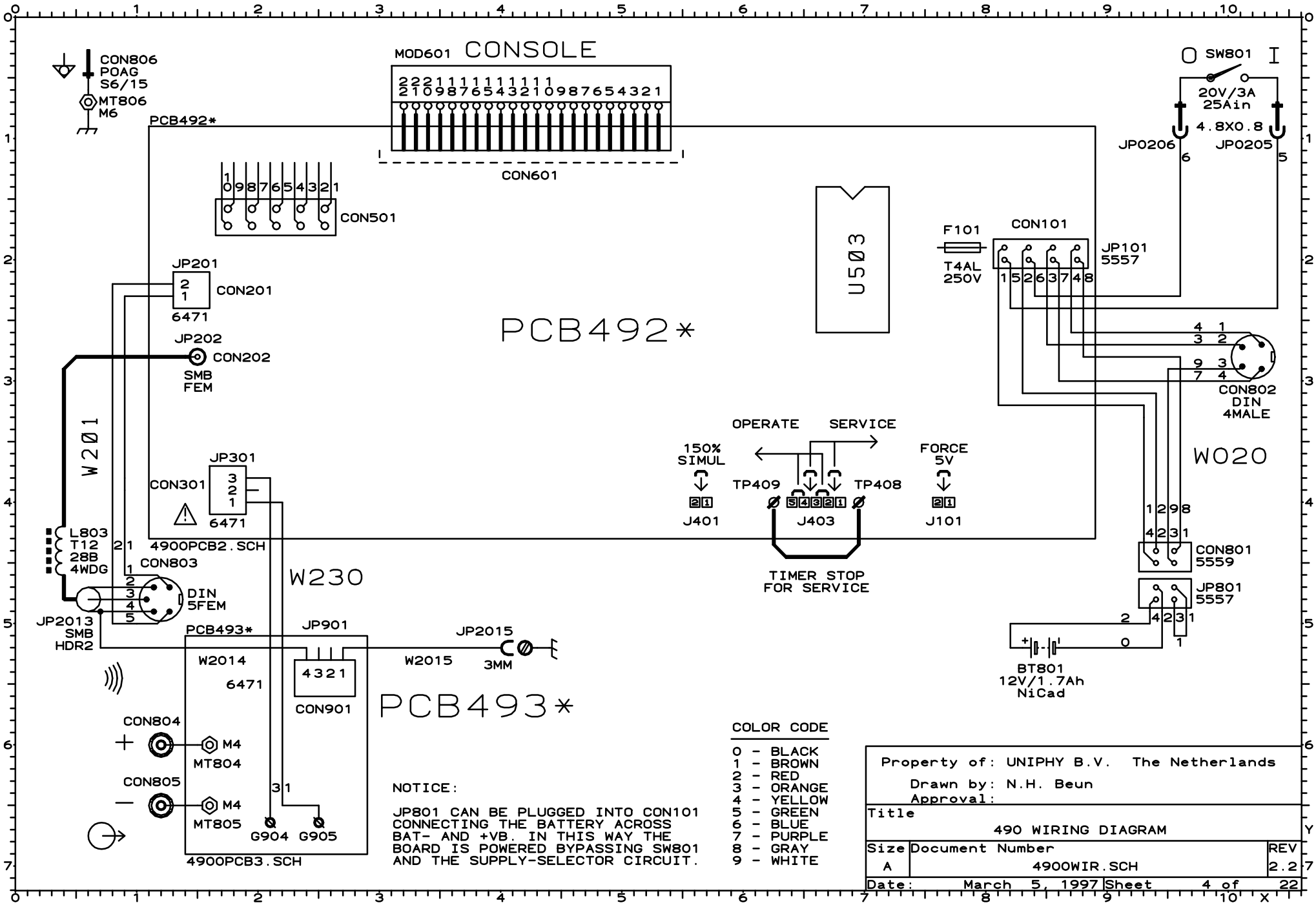
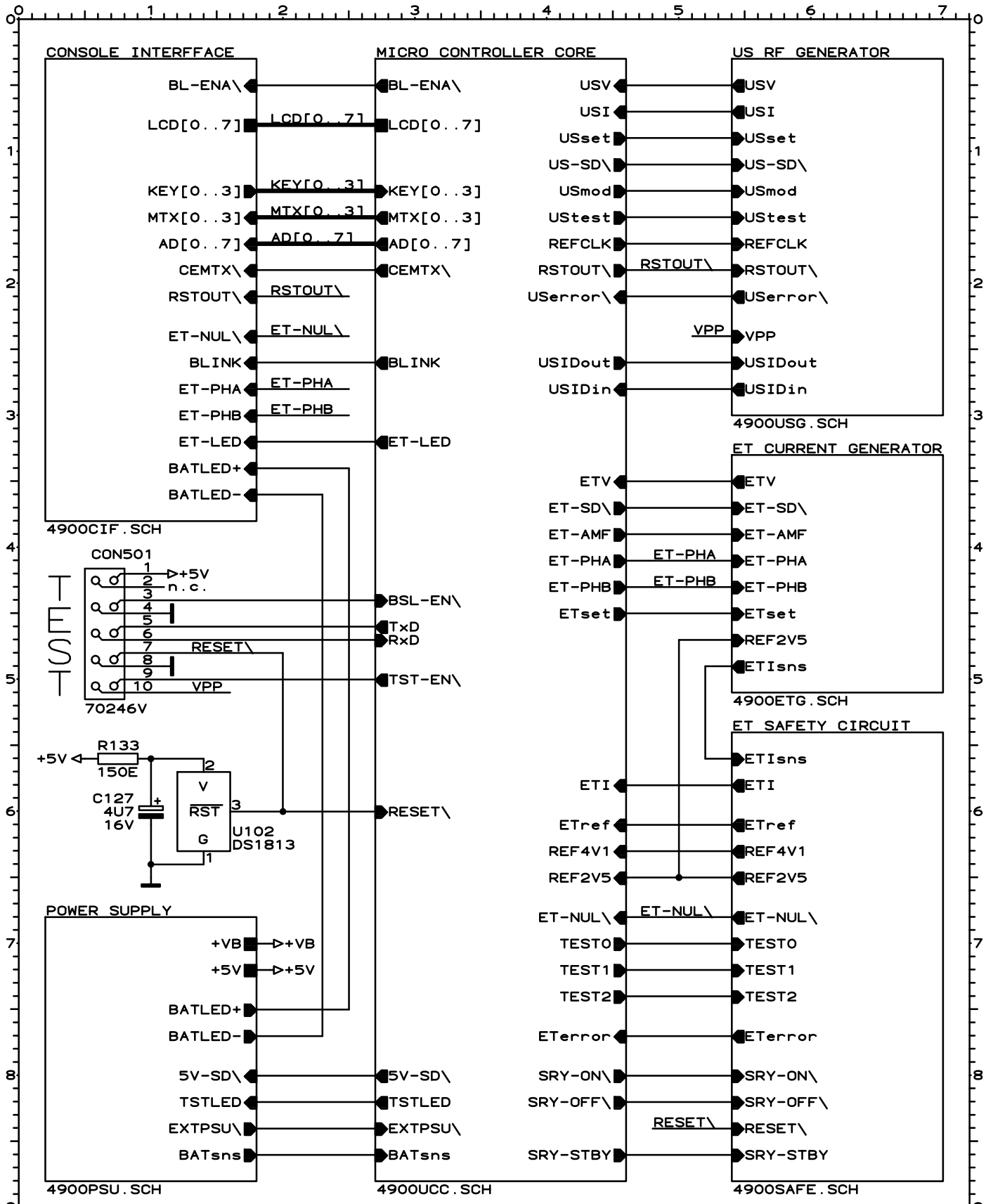
Sheet 19c Copper layout layer 2 PCB 4922
Sheet 19d Copper layout solder side PCB 4922
Sheet 20 Layout PCB 4930
Sheet 21 Component index (9 pages)
Sheet 22 Label cross-reference (2 pages)


POWER SUPPLY 18V/1.8A
-OR-
TRICKLE CHARGER 200mA
12V
0.2A
O/I
+Vb
VBsns
+5V SMPS
5V-SD
VCC
BATsns
EXT. PSU DETECTOR
EXTPSU
TxD
RxD
TST-EN
BSL-EN
CHARGING DETECTOR
POWER ON RESET
RESET
PSU
µC-CORE
EPROM 128kB
RAM 32kB
E²PROM 1kB
ADC
POR
INIT
TEST
SELF TEST
SLEEP
OPER
BATT LOW
ERROR
OFF
÷N
ET-SD\
SHUT-DOWN
CONTROLLED SMPS
ETref
DAC
ETset
VCC +5V REG
ET-AMF
TENS
PULSE LIMIT
0..2.4A
ET
ET-PHA
ET-PHB
AMF
75mΩ
1:24
ELECTRODES
SAFETY
DUMMY
DEENERGIZE
ET-ONLY
ETV
ETI
0..2.08V
180mV
150%
LIM
2.50V
2.88V
TEST0
TEST1
TEST2
TEST-SELECTOR
EN
ET-NUL
ΔT
S
R
SRY-ON
SRY-OFF
SRY-STBY
ETerror
ET-NUL
ETL-EN
BLINK
1Hz
ET-LED
MTX-COL
LED-ROW
KEY-ROW
CONSOLE
+Vb
DAC
V = k·√Pus
USset
US-OFF
UStest
USmod
USerror
SHUT-DOWN
CONTROLLED SMPS
US
2xON
OFF
÷2
PLL
OUT LOCK
1:4096
CLK
REFCLK
16MHz
Z MATCH
PLUG
US-HEAD
USI
USV
USHDtype
USIDout
USIDin
µLAN IF
DATA
GND
USguard
USref
US-NUL
4.91V
LCD 16X1
BACK-LIGHT
PWM
LCD-BUS
CONTRAST
Vo
TEMPsns
TEMPERATURE SENSOR
θ
80C166
µ CONTROLLER
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Title
490 BLOCK DIAGRAM
Size C
Document Number 4900BLK.SHT
REV 2.2
Date: March 5, 1997 Sheet 2 of 22



Property of: UNIPHY B.V. The Netherlands		
Drawn by: N.H. Beun		
Approval:		
Title: 490 ISOLATION DIAGRAM		
Size: B	Document Number: 4900ISO.SHT	REV: 2.2
Date: March 5, 1997	Sheet 3 of 22	


CONSOLE
MOD601
CON806
POAG
S6/15
MT806
M6
PCB492*
CON601
CON501
SW801
20V/3A
25Ain
4.8X0.8
JP0206
JP0205
U503
F101
T4AL
250V
CON101
JP101
5557
JP201
CON201
6471
JP202
CON202
SMB
FEM
PCB492*
CON802
DIN
4MALE
W020
W201
JP301
CON301
6471
OPERATE
SERVICE
150%
SIMUL
TP409
TP408
FORCE
5V
J401
J403
J101
TIMER STOP
FOR SERVICE
4900PCB2.SCH
L803
T12
28B
4WDG
CON803
DIN
5FEM
W230
CON801
5559
JP801
5557
JP2013
SMB
HDR2
PCB493*
JP901
JP2015
W2015
3MM
W2014
6471
CON901
BT801
12V/1.7Ah
NiCad
CON804
MT804
M4
CON805
MT805
M4
G904
G905
4900PCB3.SCH
NOTICE:
JP801 CAN BE PLUGGED INTO CON101
CONNECTING THE BATTERY ACROSS
BAT- AND +VB. IN THIS WAY THE
BOARD IS POWERED BYPASSING SW801
AND THE SUPPLY-SELECTOR CIRCUIT.
COLOR CODE
0 - BLACK
1 - BROWN
2 - RED
3 - ORANGE
4 - YELLOW
5 - GREEN
6 - BLUE
7 - PURPLE
8 - GRAY
9 - WHITE
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Title
490 WIRING DIAGRAM
Size
A
Document Number
4900WIR.SCH
REV
2.2
Date: March 5, 1997
Sheet 4 of 22



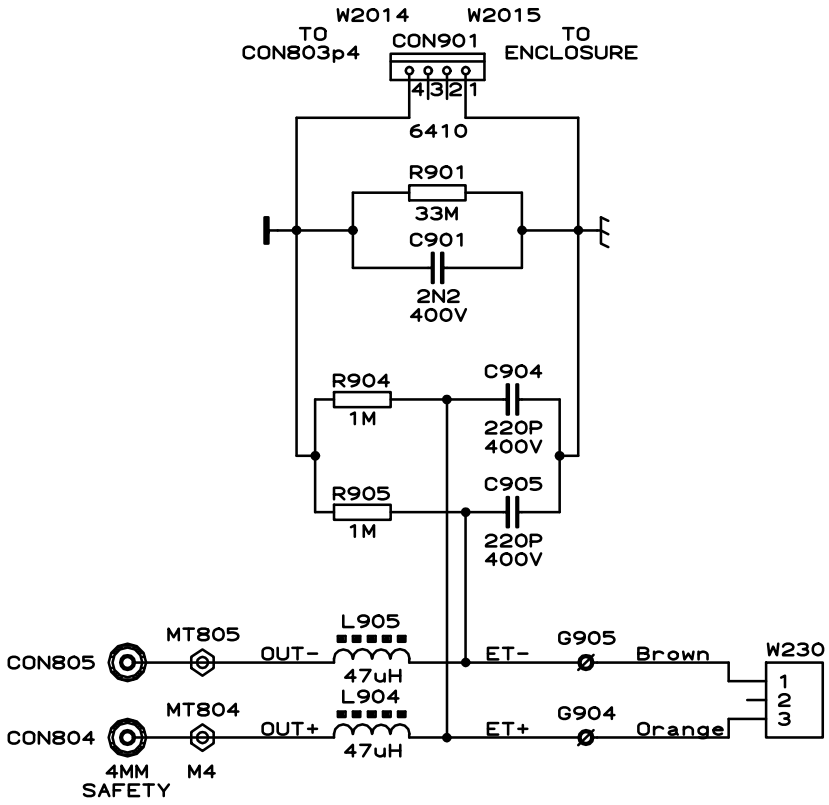
Property of: UNIPHY B.V. The Netherlands

Drawn by: N.H. Beun
Approval:
Location: PCB 492*

Title
490 MAIN PCB 4921

Size	Document Number	REV
D	4900PCB2.SCH	2.2

Date: March 5, 1997 Sheet 5 of 19



CREEPAGE ALL CIRCUITS TO CHASSIS ( )

IS MORE THEN 4 mm (CHASSIS = EP)

MUTUAL CLEARANCE ALL OTHER CIRCUITS

IS 1 mm OR MORE

ET± AND OUT± TRACES RATED FOR 100mArms

Property of: UNIPHY B.V. The Netherlands

Drawn by: N.H. Beun

Approval:

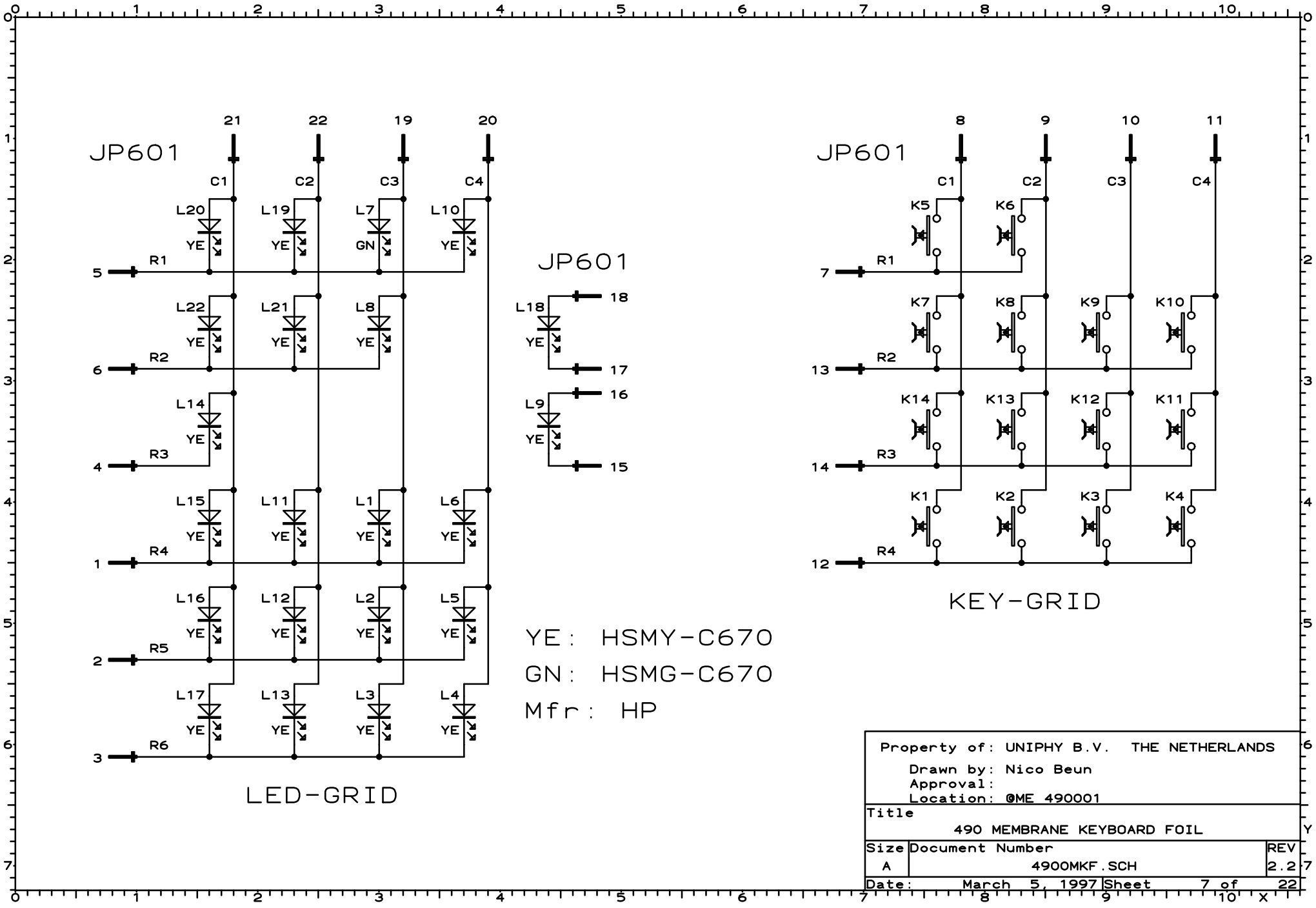
Location: PCB 493*

Title

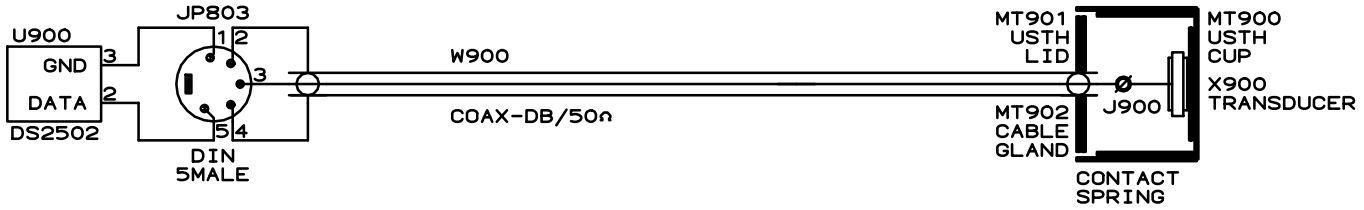
490 OUTPUT FILTER

Size	Document Number	REV
D	4900PCB3.SCH	2.2

Date: March 5, 1997 Sheet 6 of 22

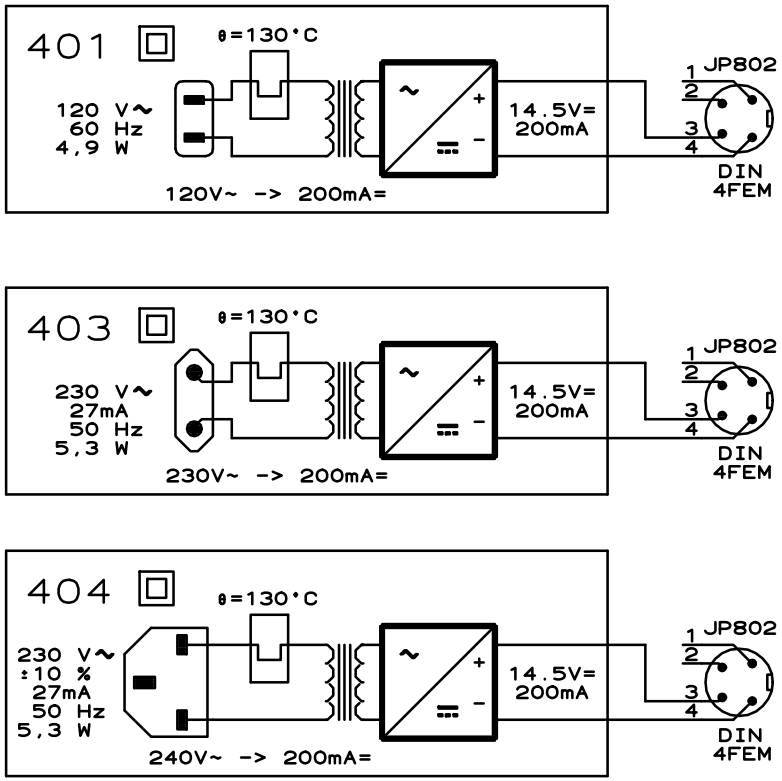

JP601
21
22
19
20
C1
C2
C3
C4
L20
L19
L7
L10
YE
YE
GN
YE
R1
5
L22
L21
L8
YE
YE
YE
R2
6
L14
YE
R3
4
L15
L11
L1
L6
YE
YE
YE
YE
R4
1
L16
L12
L2
L5
YE
YE
YE
YE
R5
2
L17
L13
L3
L4
YE
YE
YE
YE
R6
3
LED-GRID
JP601
L18
18
YE
17
L9
16
YE
15
YE: HSMY-C670
GN: HSMG-C670
Mfr: HP
JP601
8
9
10
11
C1
C2
C3
C4
K5
K6
R1
7
K7
K8
K9
K10
R2
13
K14
K13
K12
K11
R3
14
K1
K2
K3
K4
R4
12
KEY-GRID
Property of: UNIPHY B.V. THE NETHERLANDS
Drawn by: Nico Beun
Approval:
Location: @ME 490001
Title
490 MEMBRANE KEYBOARD FOIL
Size
A
Document Number
4900MKF.SCH
REV
2.2
Date: March 5, 1997
Sheet 7 of 22

ULTRASOUND TREATMENT HEADS

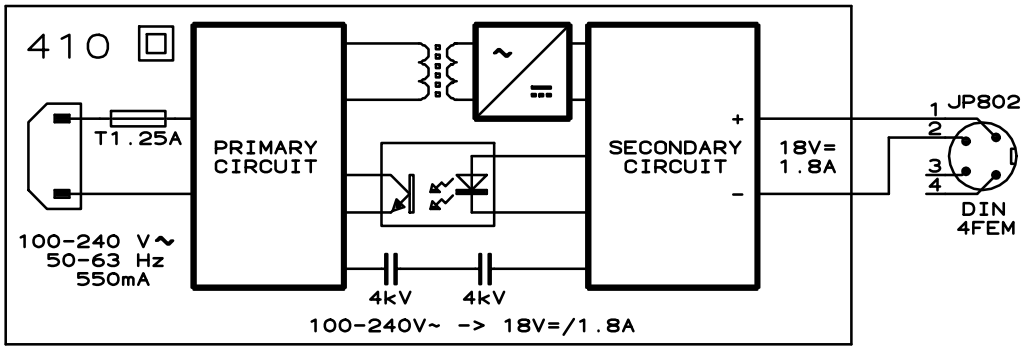


Type	X900	ERA
491	D13	1cm²
492	D38	4cm²

TRICKLE CHARGERS



UNIVERSAL MAINS POWER SUPPLY



Property of: UNIPHY B.V. The Netherlands

Drawn by: N.H. Beun

Approval:

Title: 490 ACCOMPANYING EQUIPMENT

Size	Document Number	REV
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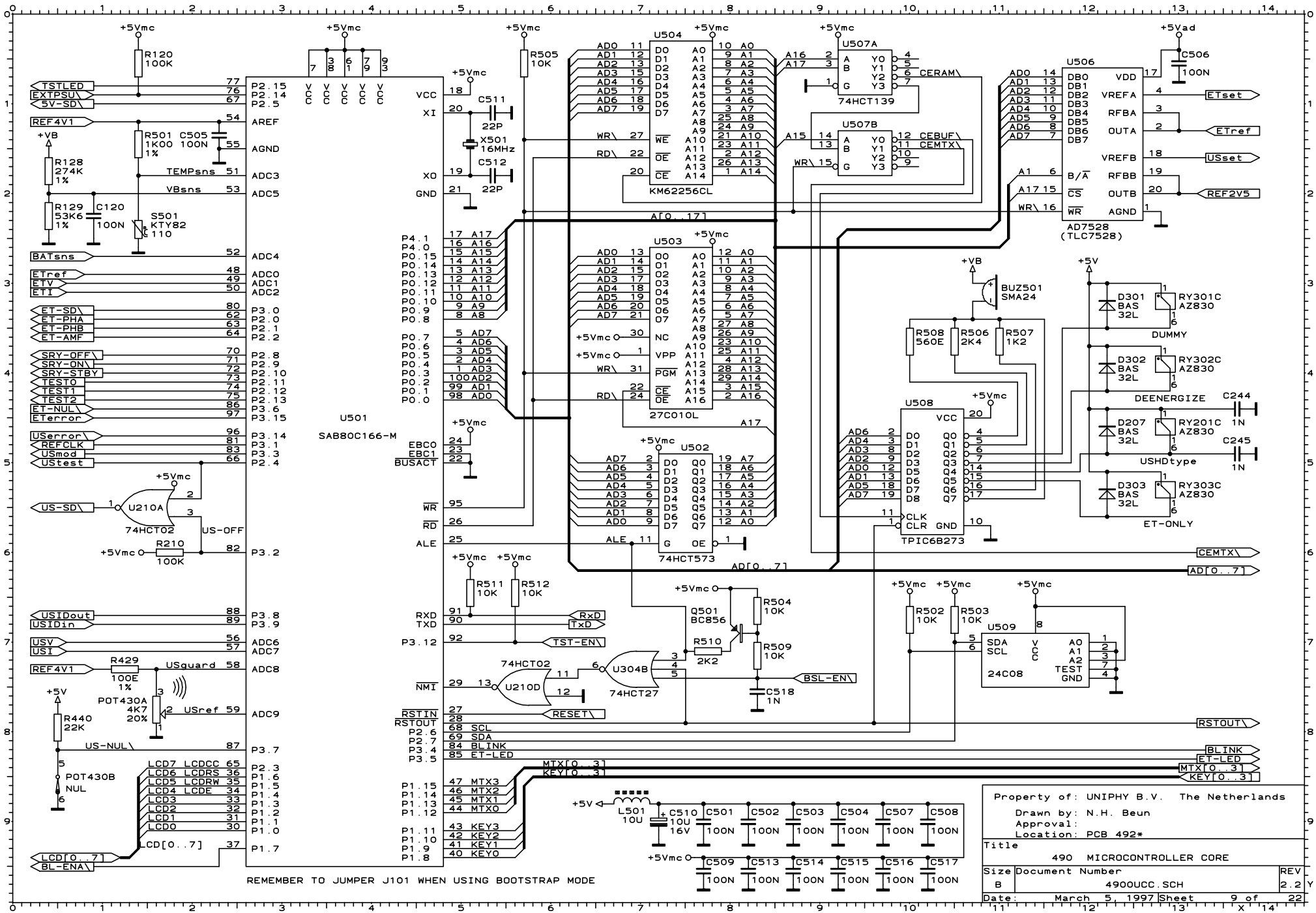
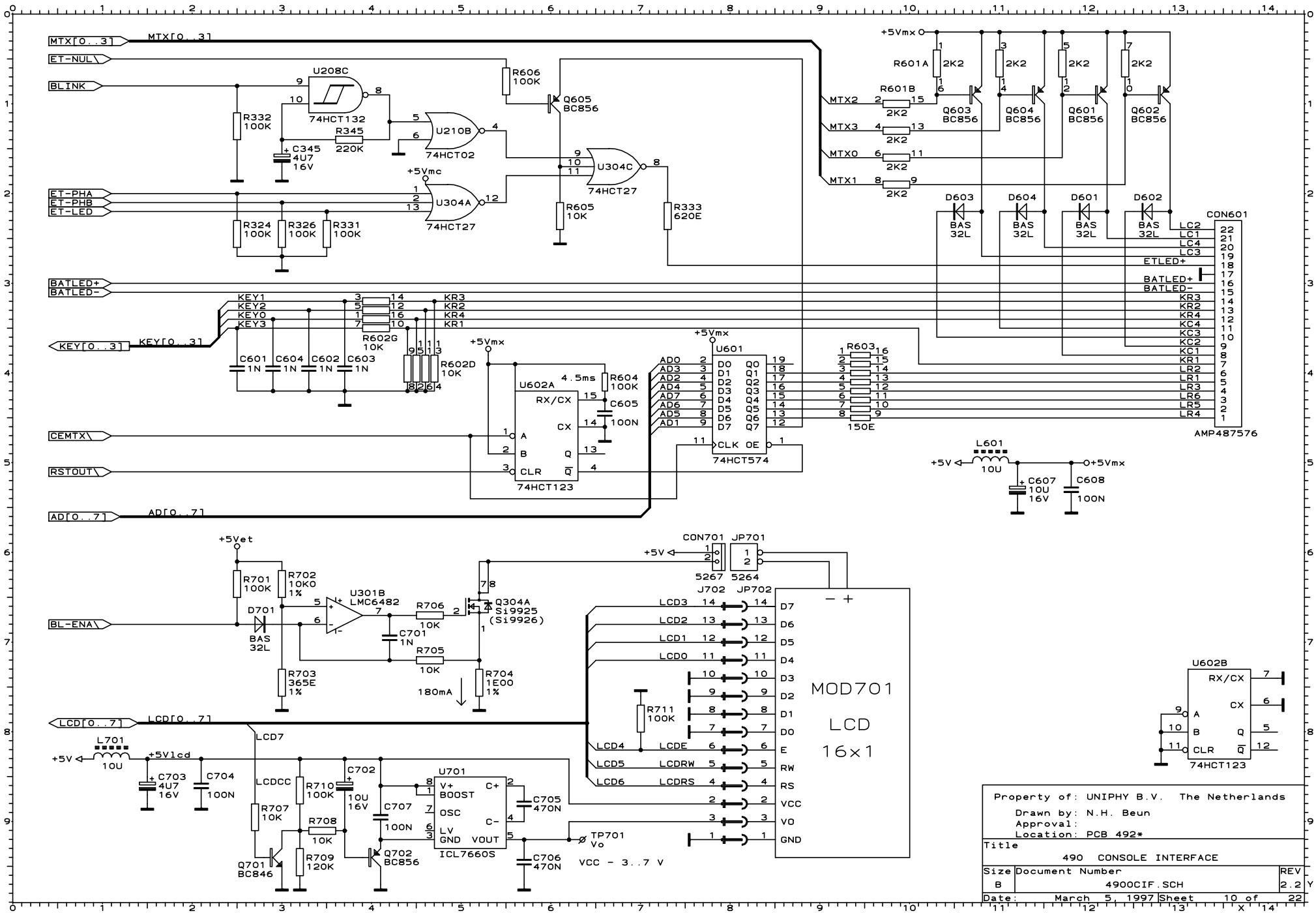
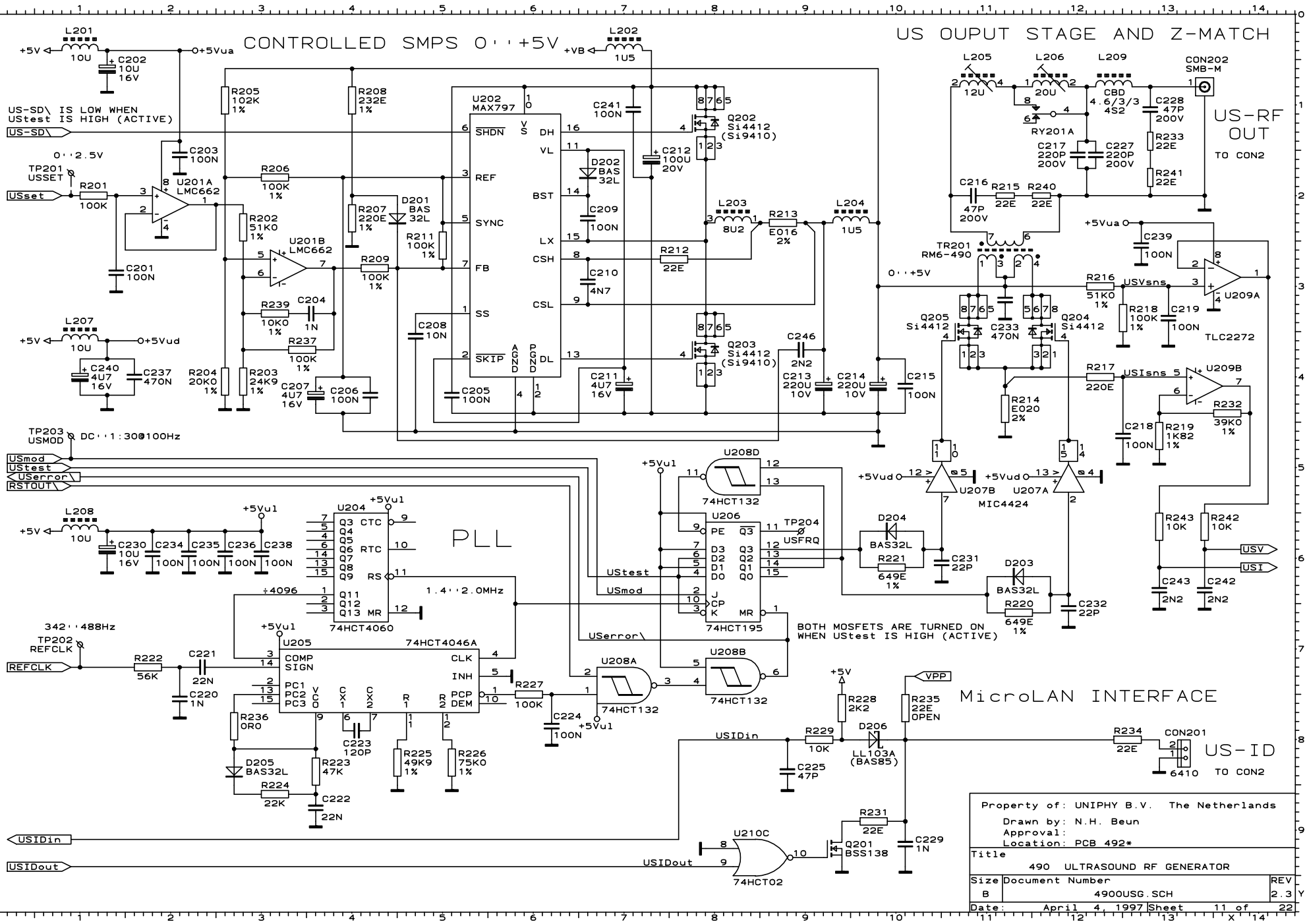
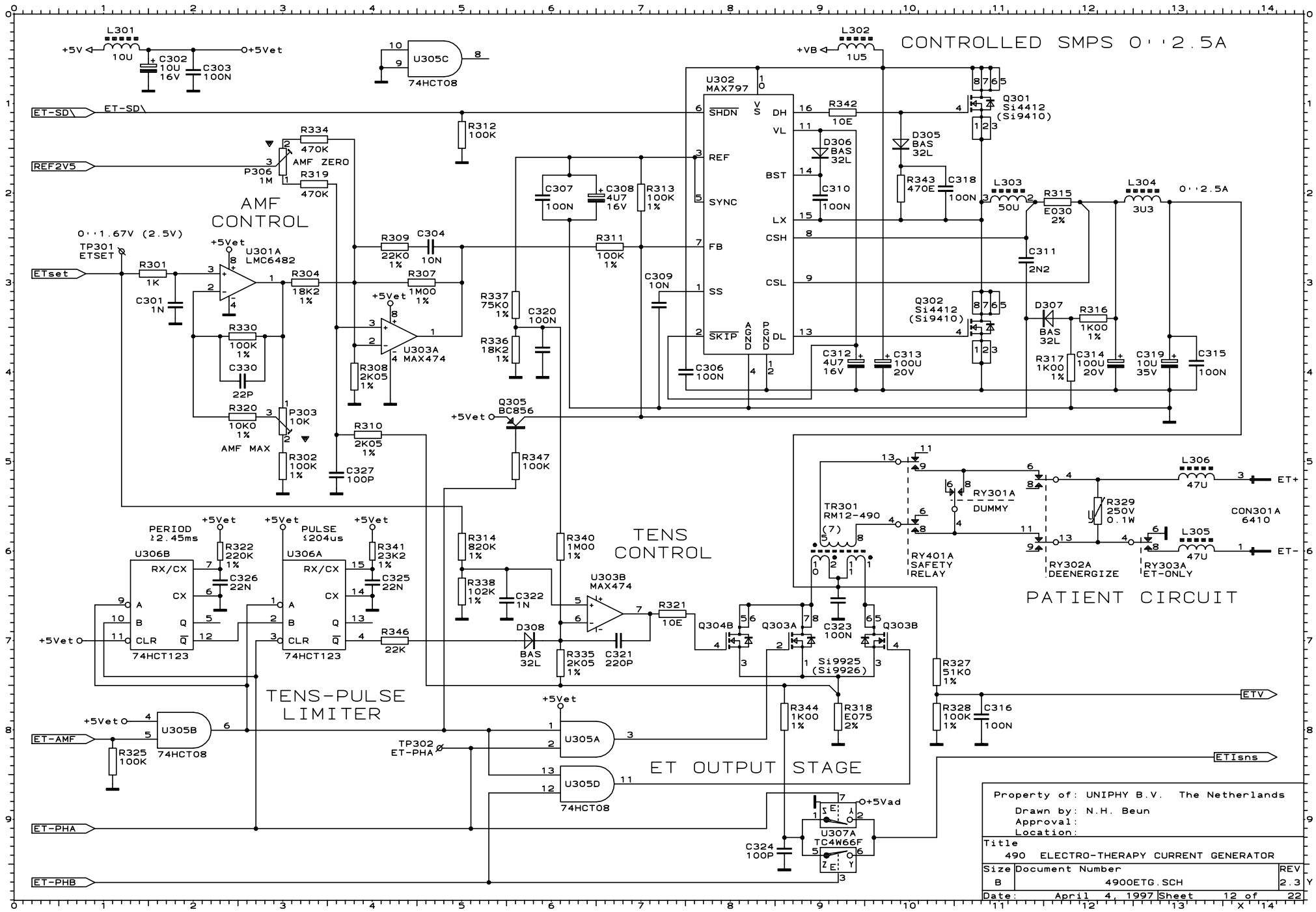
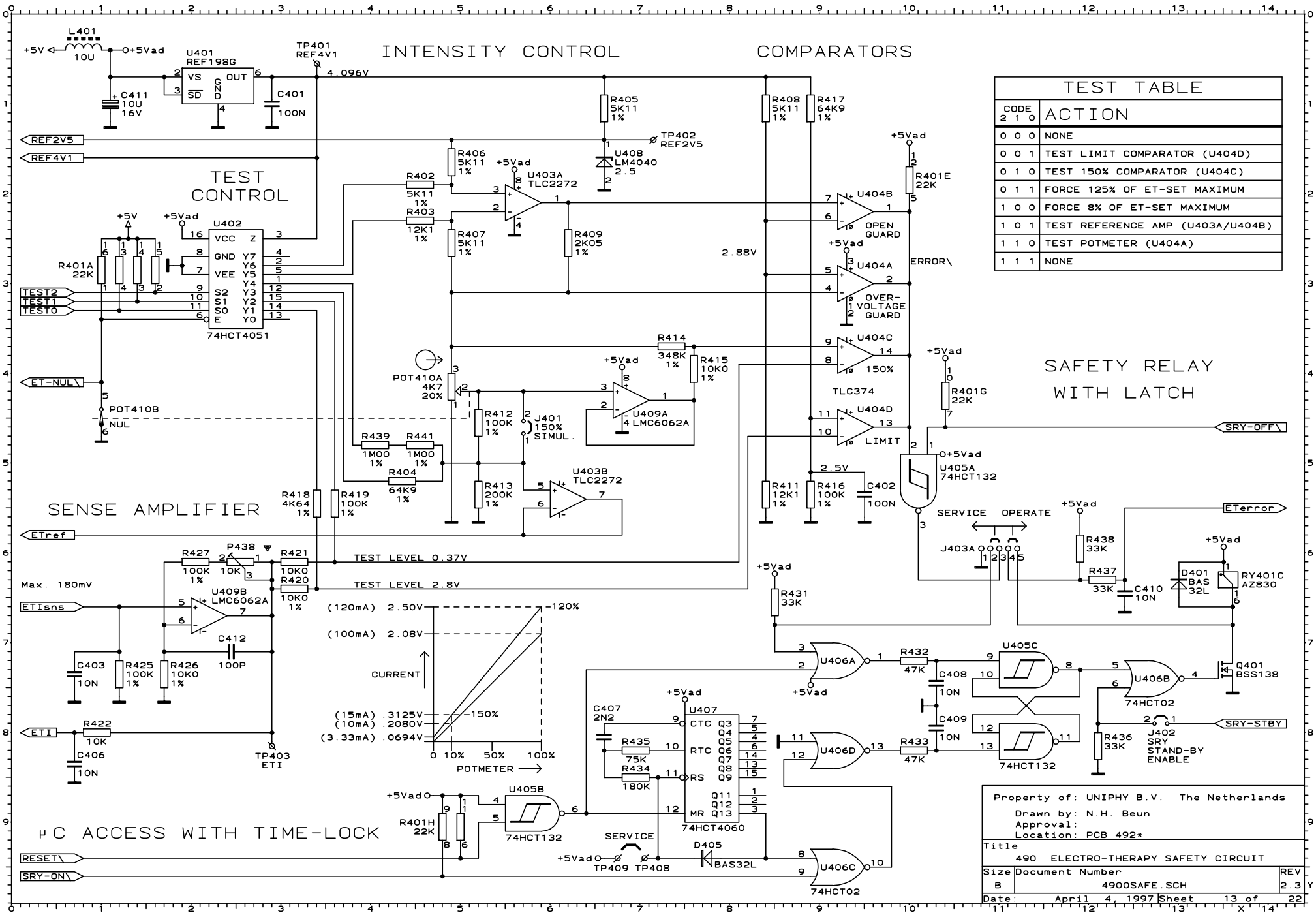
Date: March 5, 1997 Sheet 8 of 22

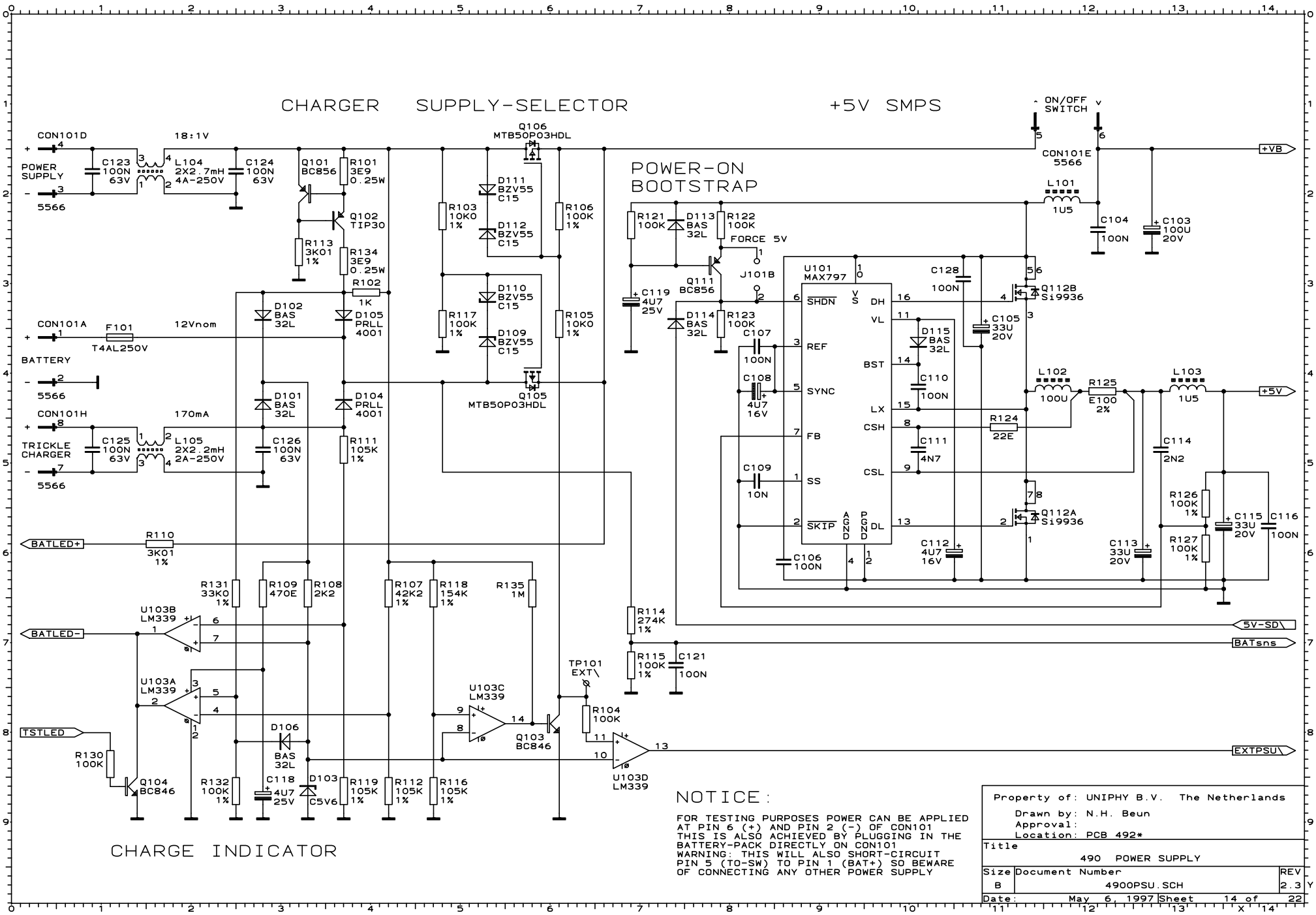

U501
SAB80C166-M
U504
KM62256CL
U503
27C010L
U502
74HCT573
U507A
74HCT139
U507B
U506
AD7528
(TLC7528)
U508
TPIC6B273
U509
24C08
U210A
74HCT02
U210D
74HCT02
U304B
74HCT27
Q501
BC856
BUZ501
SMA24
X501
16MHz
S501
KTY82
110
POT430A
4K7
20%
POT430B
NUL
R120
100K
R505
10K
R128
274K
1%
R501
1K00
1%
R505
100N
R129
53K6
1%
R120
100N
R429
100E
1%
R440
22K
R210
100K
R511
10K
R512
10K
R502
10K
R503
10K
R504
10K
R509
10K
R510
2K2
R508
560E
R506
2K4
R507
1K2
C511
22P
C512
22P
C506
100N
C518
1N
C244
1N
C245
1N
C510
10U
16V
L501
10U
C501
C502
C503
C504
C507
C508
C509
C513
C514
C515
C516
C517
100N
D301
BAS
32L
D302
BAS
32L
D207
BAS
32L
D303
BAS
32L
RY301C
AZ830
RY302C
AZ830
RY201C
AZ830
RY303C
AZ830
DUMMY
DEENERGIZE
USHDtype
ET-ONLY
+5Vmc
+5Vad
+5V
+VB
TSTLED
EXTPSU\
5V-SD\
REF4V1
TEMPsns
VBsns
BATsns
ETref
ETV
ETI
ET-SD\
ET-PHA
ET-PHB
ET-AMF
SRY-OFF\
SRY-ON\
SRY-STBY
TEST0
TEST1
TEST2
ET-NUL\
ETerror
USerror
REFCLK
USmod
UStest
US-SD\
US-OFF
USIDout
USIDin
USV
USI
USguard
USref
US-NUL\
LCD7 LCDCC
LCD6 LCDRS
LCD5 LCDRW
LCD4 LCDE
LCD3
LCD2
LCD1
LCD0
LCD[0..7]
LCD[0..7]
BL-ENA\
A[0..17]
AD[0..7]
A17
WR\
RD\
ALE
RxD
TxD
TST-EN\
BSL-EN\
RESET\
RSTOUT\
SCL
SDA
BLINK
ET-LED
MTX[0..3]
KEY[0..3]
CERAM\
CEBUF\
CEMTX\
ETset
ETref
USset
REF2V5
REMEMBER TO JUMPER J101 WHEN USING BOOTSTRAP MODE
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Location: PCB 492*
Title
490 MICROCONTROLLER CORE
Size B
Document Number 4900UCC.SCH
REV 2.2
Date: March 5, 1997
Sheet 9 of 22

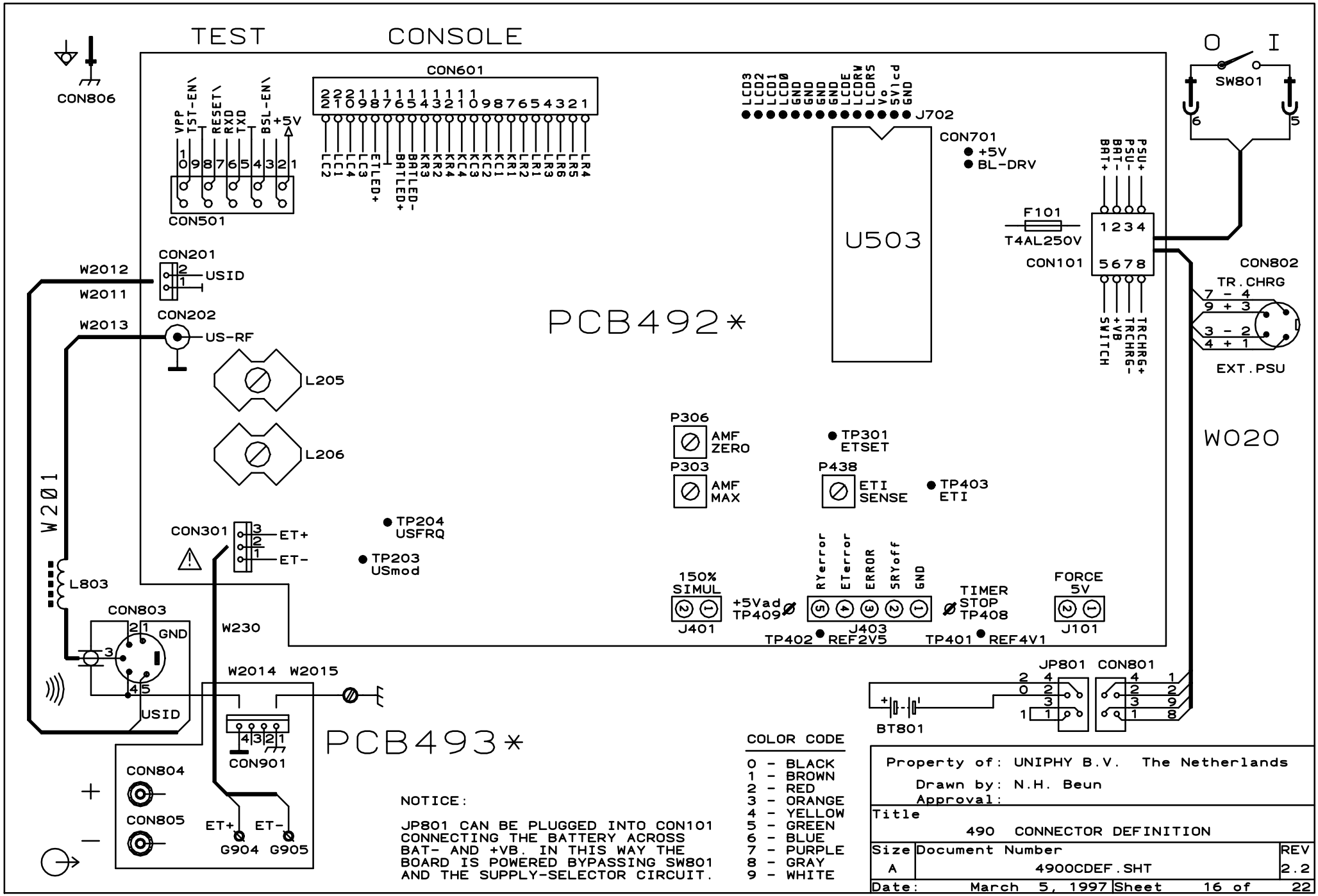

MTX[0..3]
ET-NUL\
BLINK
U208C
74HCT132
R332 100K
R345 220K
C345 4U7 16V
U210B
74HCT02
R606 100K
Q605 BC856
U304C
74HCT27
R605 10K
R333 620E
+5Vmc
U304A
74HCT27
ET-PHA
ET-PHB
ET-LED
R324 100K
R326 100K
R331 100K
+5Vmx
R601A 2K2
R601B 2K2
MTX2
MTX3
MTX0
MTX1
Q603 BC856
Q604 BC856
Q601 BC856
Q602 BC856
D603 BAS 32L
D604 BAS 32L
D601 BAS 32L
D602 BAS 32L
CON601
AMP487576
ETLED+
BATLED+
BATLED-
KEY1
KEY2
KEY0
KEY3
KEY[0..3]
R602G 10K
R602D 10K
C601 1N
C604 1N
C602 1N
C603 1N
KR3
KR2
KR4
KR1
U602A
4.5ms
R604 100K
C605 100N
RX/CX
CX
CLR
74HCT123
U601
74HCT574
AD0
AD3
AD2
AD4
AD7
AD6
AD5
AD1
CLK OE
R603 150E
L601 10U
C607 10U 16V
C608 100N
+5V
CEMTX\
RSTOUT\
AD[0..7]
+5Vet
R701 100K
R702 10K0 1%
R703 365E 1%
R704 1E00 1%
R705 10K
R706 10K
R710 100K
R711 100K
R707 10K
R708 10K
R709 120K
C701 1N
C702 10U 16V
C703 4U7 16V
C704 100N
C705 470N
C706 470N
C707 100N
D701 BAS 32L
U301B LMC6482
Q304A Si9925 (Si9926)
180mA
BL-ENA\
LCD[0..7]
LCD7
L701 10U
+5Vlcd
LCDCC
Q701 BC846
Q702 BC856
U701
ICL7660S
V+
BOOST
OSC
LV
GND
C+
C-
VOUT
TP701 Vo
VCC - 3..7 V
CON701
JP701
5267
5264
J702
JP702
LCD3
LCD2
LCD1
LCD0
LCD4
LCD5
LCD6
LCDE
LCDRW
LCDRS
D7
D6
D5
D4
D3
D2
D1
D0
E
RW
RS
VCC
VO
GND
MOD701
LCD
16x1
U602B
74HCT123
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Location: PCB 492*
Title
490 CONSOLE INTERFACE
Size B
Document Number 4900CIF.SCH
REV 2.2
Date: March 5, 1997
Sheet 10 of 22


CONTROLLED SMPS 0..+5V
US OUPUT STAGE AND Z-MATCH
US-SD\ IS LOW WHEN
UStest IS HIGH (ACTIVE)
US-SD\
0..2.5V
USset
TP201
USSET
U201A
LMC662
U201B
LMC662
U202
MAX797
SHDN
REF
SYNC
FB
SS
SKIP
VS
DH
VL
BST
LX
CSH
CSL
DL
AGND
PGND
Q202
Si4412
(Si9410)
Q203
Si4412
(Si9410)
D201
BAS
32L
D202
BAS
32L
L201
L202
L203
L204
L205
L206
L207
L208
L209
+5V
+VB
+5Vua
+5Vud
+5Vul
1U5
8U2
12U
20U
CBD
4.6/3/3
4S2
RY201A
CON202
SMB-M
US-RF
OUT
TO CON2
TR201
RM6-490
Q204
Si4412
Q205
Si4412
U209A
U209B
TLC2272
U207A
U207B
MIC4424
USVsns
USIsns
0..+5V
TP203
USMOD
DC..1:30@100Hz
USmod
UStest
USerror\
RSTOUT\
PLL
U204
74HCT4060
U205
74HCT4046A
U206
74HCT195
U208A
U208B
U208C
U208D
74HCT132
74HCT02
÷4096
1.4..2.0MHz
342..488Hz
TP202
REFCLK
TP204
USFRQ
BOTH MOSFETS ARE TURNED ON
WHEN UStest IS HIGH (ACTIVE)
MicroLAN INTERFACE
US-ID
TO CON2
CON201
6410
USIDin
USIDout
VPP
D204
BAS32L
D203
BAS32L
D205
BAS32L
D206
LL103A
(BAS85)
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Location: PCB 492*
Title
490 ULTRASOUND RF GENERATOR
Size B
Document Number 4900USG.SCH
REV 2.3
Date: April 4, 1997
Sheet 11 of 22


CONTROLLED SMPS 0''2.5A
AMF CONTROL
TENS CONTROL
TENS-PULSE LIMITER
ET OUTPUT STAGE
PATIENT CIRCUIT
U302 MAX797
U301A LMC6482
U303A MAX474
U303B MAX474
U305A
U305B
U305C
U305D
74HCT08
U306A
U306B
74HCT123
U307A TC4W66F
TR301 RM12-490
RY301A DUMMY
RY401A SAFETY RELAY
RY302A DEENERGIZE
RY303A ET-ONLY
CON301A 6410
Q301 Si4412 (Si9410)
Q302 Si4412 (Si9410)
Q303A
Q303B
Q304B
Si9925 (Si9926)
Q305 BC856
D305 BAS 32L
D306 BAS 32L
D307 BAS 32L
D308 BAS 32L
AMF ZERO
AMF MAX
0''1.67V (2.5V)
0''2.5A
+5V
+5Vet
+VB
+5Vad
ET-SD
REF2V5
ETset
ET-AMF
ET-PHA
ET-PHB
ETV
ETIsns
TP301 ETSET
TP302 ET-PHA
PERIOD ≥2.45ms
PULSE ≤204us
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Location:
Title
490 ELECTRO-THERAPY CURRENT GENERATOR
Size B
Document Number 4900ETG.SCH
REV 2.3
Date: April 4, 1997
Sheet 12 of 22


INTENSITY CONTROL
COMPARATORS
TEST CONTROL
SENSE AMPLIFIER
SAFETY RELAY WITH LATCH
µC ACCESS WITH TIME-LOCK
TEST TABLE
CODE 2 1 0
ACTION
0 0 0 NONE
0 0 1 TEST LIMIT COMPARATOR (U404D)
0 1 0 TEST 150% COMPARATOR (U404C)
0 1 1 FORCE 125% OF ET-SET MAXIMUM
1 0 0 FORCE 8% OF ET-SET MAXIMUM
1 0 1 TEST REFERENCE AMP (U403A/U404B)
1 1 0 TEST POTMETER (U404A)
1 1 1 NONE
L401
10U
+5V
+5Vad
U401
REF198G
TP401
REF4V1
4.096V
C411
10U
16V
C401
100N
REF2V5
REF4V1
R405
5K11
1%
TP402
REF2V5
U408
LM4040
2.5
R406
5K11
1%
R402
5K11
1%
R403
12K1
1%
R407
5K11
1%
R409
2K05
1%
U403A
TLC2272
R408
5K11
1%
R417
64K9
1%
R401E
22K
U404B
OPEN
GUARD
2.88V
ERROR\
U404A
OVER-
VOLTAGE
GUARD
U402
74HCT4051
R401A
22K
TEST2
TEST1
TEST0
ET-NUL\
POT410B
NUL
POT410A
4K7
20%
R414
348K
1%
R415
10K0
1%
U404C
150%
TLC374
U404D
LIMIT
R401G
22K
SRY-OFF\
U409A
LMC6062A
R412
100K
1%
J401
150%
SIMUL.
R439
1M00
1%
R441
1M00
1%
R404
64K9
1%
R413
200K
1%
U403B
TLC2272
R418
4K64
1%
R419
100K
1%
R411
12K1
1%
R416
100K
1%
C402
100N
2.5V
U405A
74HCT132
SERVICE
OPERATE
J403A
ETref
R427
100K
1%
P438
10K
R421
10K0
1%
R420
10K0
1%
TEST LEVEL 0.37V
TEST LEVEL 2.8V
Max. 180mV
ETIsns
U409B
LMC6062A
C403
10N
R425
100K
1%
R426
10K0
1%
C412
100P
(120mA) 2.50V
(100mA) 2.08V
CURRENT
(15mA) .3125V
(10mA) .2080V
(3.33mA) .0694V
-120%
-150%
0 10% 50% 100%
POTMETER
ETI
R422
10K
C406
10N
TP403
ETI
R431
33K
U406A
R432
47K
C408
10N
C409
10N
U405C
U406B
74HCT02
Q401
BSS138
U406D
R433
47K
74HCT132
R438
33K
R437
33K
C410
10N
D401
BAS
32L
RY401C
AZ830
ETerror
R436
33K
J402
SRY
STAND-BY
ENABLE
SRY-STBY
C407
2N2
R435
75K
R434
180K
U407
CTC Q3
RTC Q4 Q5 Q6 Q7 Q8 Q9
RS
Q11 Q12 Q13
MR
74HCT4060
R401H
22K
U405B
74HCT132
SERVICE
TP409 TP408
D405
BAS32L
U406C
74HCT02
RESET\
SRY-ON\
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Location: PCB 492*
Title
490 ELECTRO-THERAPY SAFETY CIRCUIT
Size B
Document Number 4900SAFE.SCH
REV 2.3
Date: April 4, 1997
Sheet 13 of 22


CHARGER SUPPLY-SELECTOR
+5V SMPS
CON101D
POWER SUPPLY
5566
18:1V
C123 100N 63V
L104 2X2.7mH 4A-250V
C124 100N 63V
Q101 BC856
Q102 TIP30
R101 3E9 0.25W
R113 3K01 1%
R134 3E9 0.25W
R102 1K
Q106 MTB50P03HDL
D111 BZV55 C15
D112 BZV55 C15
D110 BZV55 C15
D109 BZV55 C15
R103 10K0 1%
R117 100K 1%
R106 100K 1%
R105 10K0 1%
Q105 MTB50P03HDL
CON101A
F101
T4AL250V
12Vnom
BATTERY
D102 BAS 32L
D105 PRLL 4001
D101 BAS 32L
D104 PRLL 4001
CON101H
TRICKLE CHARGER
170mA
C125 100N 63V
L105 2X2.2mH 2A-250V
C126 100N 63V
R111 105K 1%
BATLED+
R110 3K01 1%
BATLED-
R131 33K0 1%
R109 470E
R108 2K2
R107 42K2 1%
R118 154K 1%
R135 1M
U103B LM339
U103A LM339
U103C LM339
U103D LM339
TSTLED
R130 100K
Q104 BC846
R132 100K 1%
C118 4U7 25V
D106 BAS 32L
D103 C5V6
R119 105K 1%
R112 105K 1%
R116 105K 1%
Q103 BC846
TP101 EXT\
R104 100K
R114 274K 1%
R115 100K 1%
C121 100N
CHARGE INDICATOR
POWER-ON BOOTSTRAP
ON/OFF SWITCH
CON101E 5566
+VB
L101 1U5
C104 100N
C103 100U 20V
R121 100K
D113 BAS 32L
R122 100K
FORCE 5V
J101B
Q111 BC856
C119 4U7 25V
D114 BAS 32L
R123 100K
U101 MAX797
SHDN
REF
SYNC
FB
SS
SKIP
VS
VL
BST
LX
CSH
CSL
DH
DL
AGND
PGND
C107 100N
C108 4U7 16V
C109 10N
C106 100N
C128 100N
C105 33U 20V
D115 BAS 32L
C110 100N
C111 4N7
C112 4U7 16V
Q112B Si9936
Q112A Si9936
L102 100U
R125 E100 2%
L103 1U5
+5V
R124 22E
C114 2N2
C113 33U 20V
R126 100K 1%
R127 100K 1%
C115 33U 20V
C116 100N
5V-SD\
BATsns
EXTPSU\
NOTICE:
FOR TESTING PURPOSES POWER CAN BE APPLIED AT PIN 6 (+) AND PIN 2 (-) OF CON101
THIS IS ALSO ACHIEVED BY PLUGGING IN THE BATTERY-PACK DIRECTLY ON CON101
WARNING: THIS WILL ALSO SHORT-CIRCUIT PIN 5 (TO-SW) TO PIN 1 (BAT+) SO BEWARE OF CONNECTING ANY OTHER POWER SUPPLY
Property of: UNIPHY B.V. The Netherlands
Drawn by: N.H. Beun
Approval:
Location: PCB 492*
Title
490 POWER SUPPLY
Size B
Document Number 4900PSU.SCH
REV 2.3
Date: May 6, 1997
Sheet 14 of 22



NOTICE:

JP801 CAN BE PLUGGED INTO CON101 CONNECTING THE BATTERY ACROSS BAT- AND +VB. IN THIS WAY THE BOARD IS POWERED BYPASSING SW801 AND THE SUPPLY-SELECTOR CIRCUIT.

COLOR CODE

0 - BLACK
1 - BROWN
2 - RED
3 - ORANGE
4 - YELLOW
5 - GREEN
6 - BLUE
7 - PURPLE
8 - GRAY
9 - WHITE

Property of: UNIPHY B.V. The Netherlands

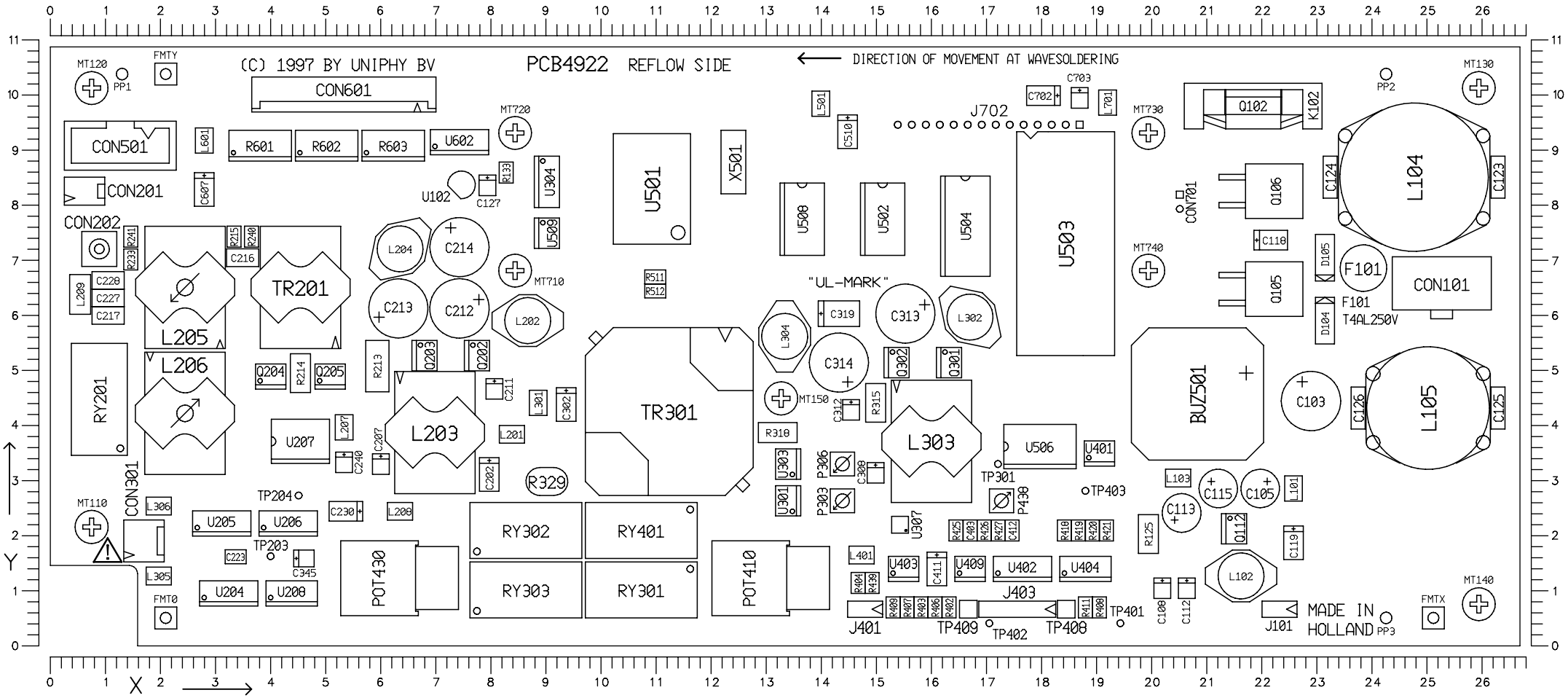
Drawn by: N.H. Beun

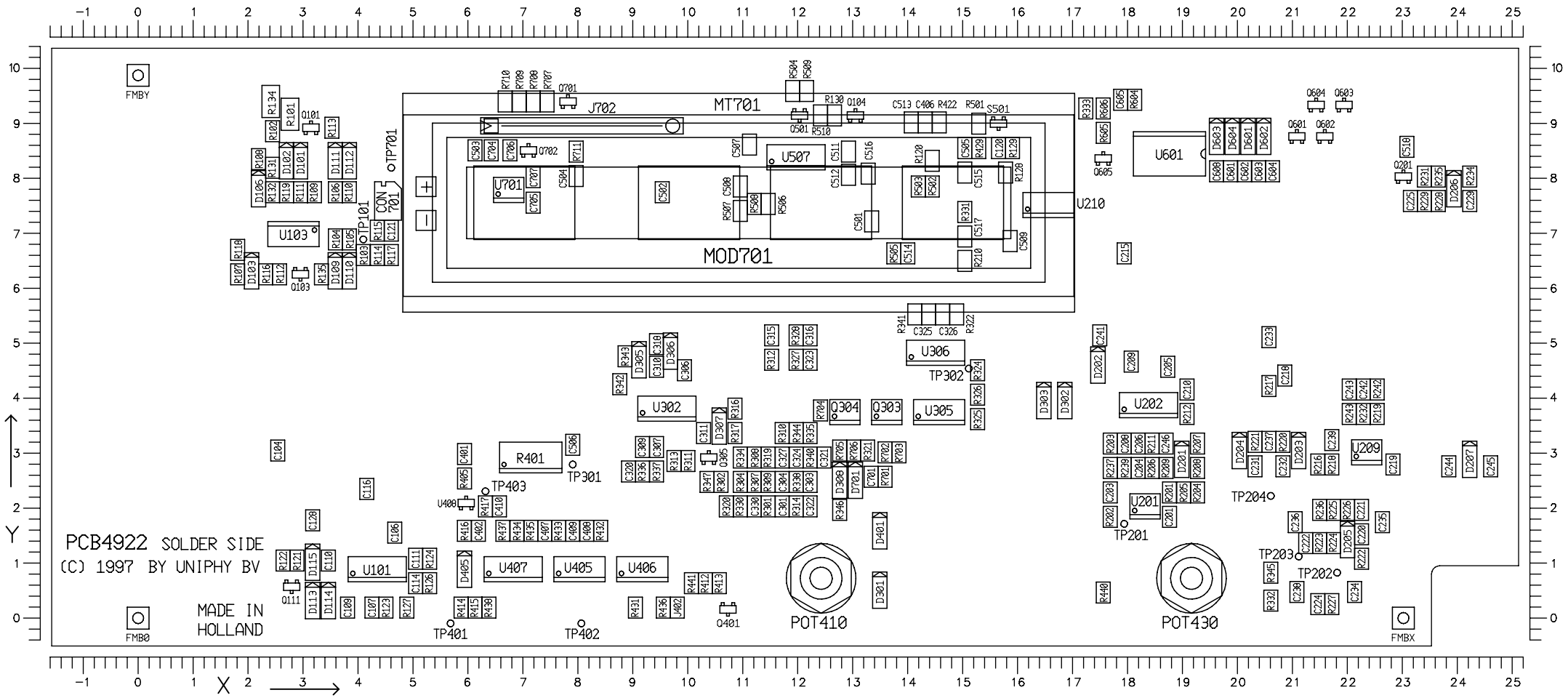
Approval:

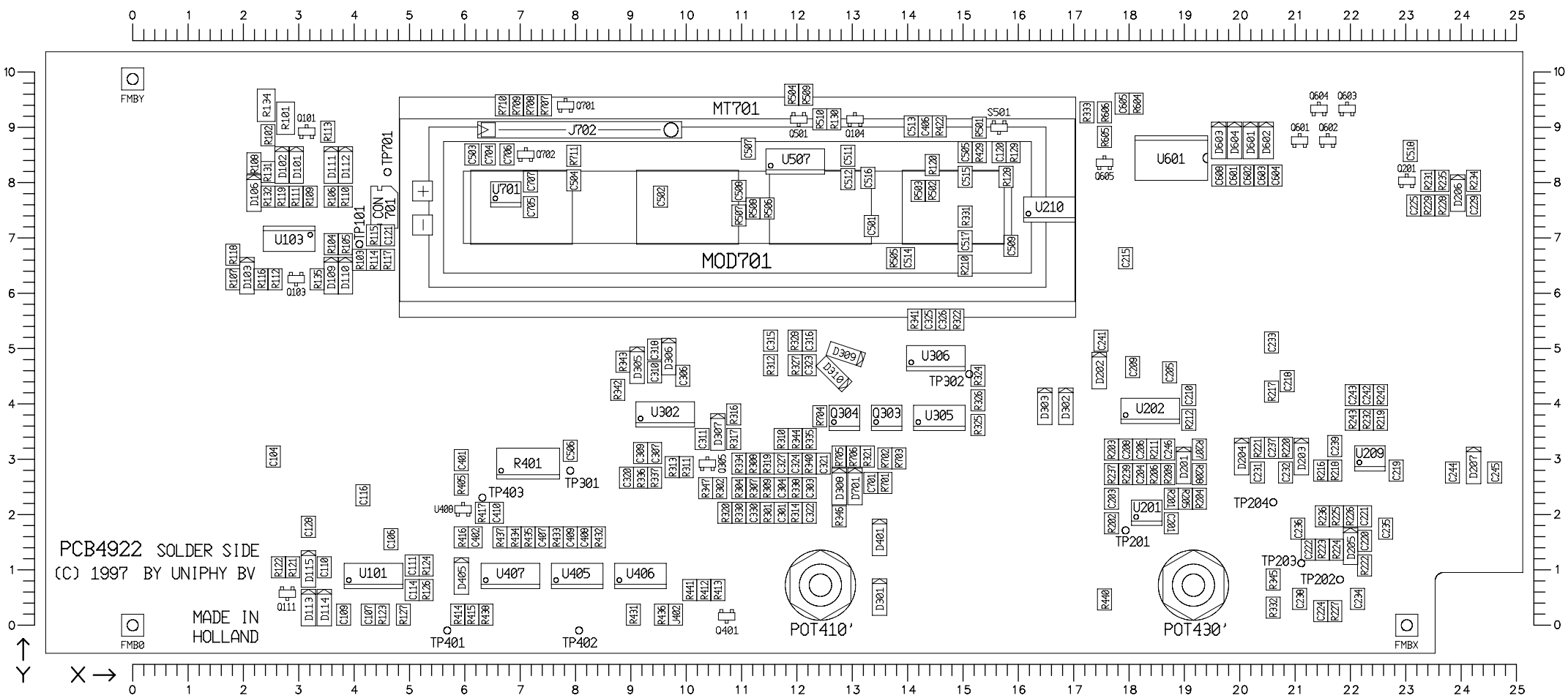
Title: 490 CONNECTOR DEFINITION

Size	Document Number	REV
A	4900CDEF.SHT	2.2

Date: March 5, 1997 Sheet 16 of 22


(C) 1997 BY UNIPHY BV
PCB4922 REFLOW SIDE
DIRECTION OF MOVEMENT AT WAVESOLDERING
"UL-MARK"
MADE IN HOLLAND
F101 T4AL250V
CON601
CON501
CON201
CON202
CON301
CON101
CON701
J702
J401
J403
J101
TR201
TR301
L205
L206
L203
L204
L202
L104
L105
RY201
RY302
RY401
RY303
RY301
POT430
POT410
BUZ501
U501
U503
X501
MT120
MT130
MT140
MT150
MT710
MT720
MT730
MT740
PP1
PP2
PP3
FMTY
FMT0
FMTX
TP204
TP203
TP301
TP403
TP401
TP409
TP402
TP408


PCB4922 SOLDER SIDE
(C) 1997 BY UNIPHY BV
MADE IN HOLLAND
MT701
MOD701
J702
U507
U701
U210
U601
U103
U306
U302
U305
U202
U209
U201
U101
U407
U405
U406
R401
TP701
TP101
TP302
TP301
TP403
TP401
TP402
TP201
TP204
TP203
TP202
POT410
POT430
FMBY
FMB0
FMBX
X
Y



Property of Uniphy International B.V. The Netherlands		
Drawn by: N.H. Beun		
Approval:		
Title: Components Layout Solder Side PCB 4922		
Size: A	Document Number: 4922LS.ps	REV: 2.3
Date: 6 November 2000	Page: 18 of 22	